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TECHNICAL REPORT

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THE CAMP PENDLETON EXPERIMENT IN BATTALION LEVEL FIELD FEEDING

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JULY 1976

UNITED STATES ARMY
NATICK RESEARCH and DEVELOPMENT COMMAND
NATICK, MASSACHUSETTS 01760

OPERATIONS RESEARCH/SYSTEMS
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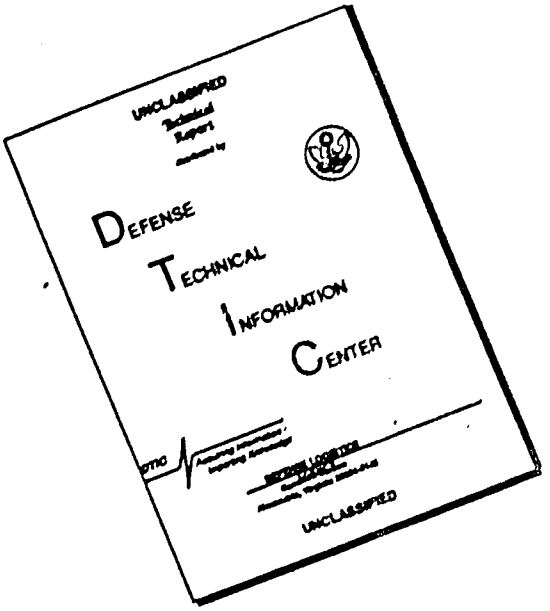

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The results of a field feeding experiment demonstrated that two new consolidated feeding systems (designated XM-75 and XM-76) were superior to the standard Marine Corps Systems, offering a 24% reduction in staffing level (4 cooks and 5 messmen) and marked improvement in the quality of sanitation. Disposable trays in place of mess kits accounted for an additional savings of 2 messmen. By comparison, the new systems would offer the Army a 49% reduction in staffing levels (15 cooks and 10 K.P.'s) as compared to company level (cont'd)

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feeding for mechanized infantry maneuver battalions. Between the two new systems, the XM-75 was considered far superior in overall performance.

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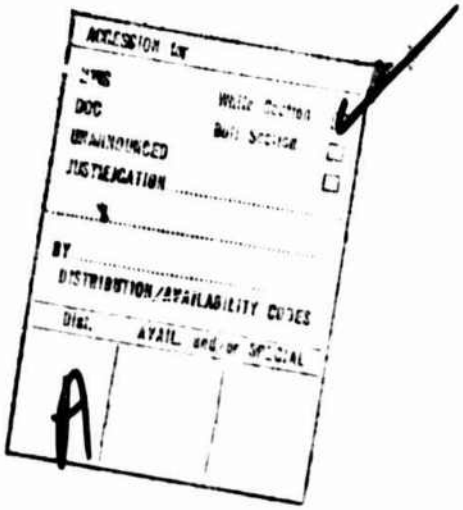

PREFACE

This report documents the results of the second of two field feeding experiments which have been conducted by NARADCOM to evaluate new configurations of large consolidated kitchens for use by the Army and Marine Corps under field conditions. These experiments were designed to validate the substantial savings of both food service personnel and kitchen attendants (KP's) projected for a typical Army division if large consolidated kitchens (battalion level) could be used in place of some of the small company kitchens. Another major purpose was to evaluate for both the Army and Marine Corps new, improved battalion level systems that have been developed as part of the project.

This work is jointly sponsored by the Army and Marine Corps and is being conducted under the DOD Food Research, Development, Testing and Engineering Program, Project No. 1Y762724AH99A.

The authors wish to acknowledge the excellent cooperation provided by Major General Mize, Commander of the 1st Marine Division and Colonel Jones, Commander of the Infantry Training School at Camp Pendleton; the invaluable assistance of Captain Frank Towers and Master Gunnery Sergeant C. V. Kane of Division Food Service Office; and the superior performance of the food service personnel participating in the experiment under the varied and difficult conditions that are inherent in an experimental situation.

The authors also wish to recognize the following NARADCOM personnel who made a significant contribution through participation in the conduct of the experiment:

Lt/Col William R. Belcher	Marine Corps-Rep., Joint Technical Staff
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CHAPTER I

INTRODUCTION

The Army and Marine Corps have jointly sponsored a comprehensive systems analysis of their current field feeding systems with the objective of achieving significant reductions in the number of operating personnel and improved performance. In addition, both services are very desirous of modernizing their field feeding systems since much of the equipment dates back to World War II in design.

Until recently, Army and Marine Corps doctrine for field feeding have differed markedly. The Army operates at company level, while the Marine Corps operates at battalion level. However, at present the Army is seriously considering consolidation of their field feeding systems. If adopted, this would bring field feeding requirements of both services much closer together. For example, under a plan for Army consolidation proposed by NARADCOM[1], the number of kitchens in a typical Army division would decrease from 115 to 50. Ten of these kitchens would range in size from 550 to 1000 customers and entail feeding at the battalion level. By comparison, a typical Marine Corps Division has only 23 field kitchens which range in size from 180 to 1220 customers. Providing quality hot meals to this many consumers under dynamic, tactical environments where hot food must be transported from 5 to 20 km from the point of preparation under widely varying terrain and climatic conditions is an extremely challenging assignment.

At present, the Army is still considering the pros and cons of consolidation which is an issue the Marine Corps does not have to face. If the Army does consolidate, then another decision is required; i.e., what will the consolidated field feeding system consist of in terms of hardware? In the case of the Marine Corps, their only decision concerns the specific improvements, if any, they should make in their field feeding system over the short term. To aid the Army and Marine Corps in making these decisions the ongoing systems study of field feeding being conducted by NARADCOM under the DOD Food RDT&Eng Program was broadened to include improvements to the existing system. The overall study now has the dual objectives of:

(1) Developing recommendations to reduce manpower requirements and improve performance of the existing system.

(2) Define and recommend new concepts based upon technological advances which minimize manpower requirements and further improve performance.

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[1]Smith, R. S., et. al., "A System Evaluation of Consolidated Field Feeding for the Army", Technical Report 75-83 OR/SA, US Army Natick Development Center, Natick, MA 01760, February 1975.

Toward accomplishing the first objective three major areas required evaluation through field experiments:

(1) The requirements for operation of a consolidated field feeding system to include minimum number of personnel and essential equipment.

(2) The relative effectiveness of different configurations of existing equipment augmented with low-risk developmental or off-the-shelf items of equipment to improve the efficiency of battalion-size systems.

(3) The tactical compatibility of a consolidated field feeding system on different type Army Divisional Units, particularly with respect to the distribution subsystems.

The first area was addressed by an experiment conducted in August 1975 at Camp Edwards, MA, with elements of the 26th (Yankee) Division of the Massachusetts Army National Guard and has been documented in a NARADCOM Technical Report[2]. The Camp Pendleton experiment was designed to address the second area and to evaluate the improvements instituted as a result of the first experiment. The distribution subsystem portion of the third area was recently assessed as part of another experiment sponsored by the Quartermaster School, Fort Lee, VA and conducted by MASSTER at Fort Hood, TX in April 1976. The results of this third experiment should be available during August 1976.

The purpose of this report is to document the results of the Camp Pendleton experiment which was conducted during the period 1 - 24 March 1976. Food service personnel participating in the experiment were from the 1st Marine Division while messmen and consumers were from units of the 1st Marine Division and the Infantry Training School.

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[2]Baritz, S., et. al., "The Camp Edwards Experiment in Battalion Level Consolidated Field Feeding", Technical Report 76-45 OR/SA, US Army Natick Research and Development Command, Natick, MA 01760, December 1975.

CHAPTER II

SUMMARY REPORT

The experiment conducted at Camp Pendleton had eight basic objectives as outlined below:

-Evaluate the performance of a new product improvement field feeding system designated the XM-75.

-Evaluate the performance of the new Mobile Kitchen Trailer (MKT) when utilized in multiple units, designated the XM-76.

-Compare the performance of the XM-75 and Multiple MKT concept against the standard Marine Corps battalion system which served as a Control.

-Determine the potential for personnel savings with the new systems as compared to the control system.

-Compare the effectiveness of sanitation provided by the three systems.

-Determine if consumers perceive any significant differences in meal acceptability among the three systems and between the A and B rations.

-Determine if the B-ration results in any labor savings as compared to the A-ration.

-Evaluate human factor aspects of each of the three systems including equipment and workspace design.

Description of the Experiment

This experiment was designed to place a realistic workload on the three systems being evaluated. This meant that two hot meals would be prepared daily including baked goods. Since combat situations generally do not allow three hot meals (sometimes only one is served), a meal discipline of a hot breakfast and supper with the noon meal being a Meal Combat Individual (MCI) was decided upon. To accomplish this, two menus were devised; one based on the A-ration and one based on the B-ration. It should be noted that the A-ration menu was repeated during each of the first three weeks while the B-ration menu was used during the fourth week. Table I provides an overview of the schedule for the experiment.

A total of approximately 900 consumers were served; 600 at remote locations and 300 at the kitchen site. Units in the field were located at distances ranging from 5 to 20 km from the kitchen site. The number of remote sites supplied with hot meals ranged from two to five depending upon the scenarios of the units undergoing field training. All three systems were operated for five consecutive days with weekends off.

During the first week all consumers used the standard mess kit while during the remainder of the experiment disposable mess gear was used by all consumers, thus allowing evaluation of the labor required to maintain the mess kit wash lines.

TABLE 1. CAMP PENDLETON EXPERIMENT SCHEDULE

	Week I	Week II	Week III	Week IV
Systems	Standard Marine Corps battalion kitchen (Control)	XM-75	Multiple MKT's	XM-75/ XM-76
Type of Food	A-ration Breakfast & Supper, MCI Lunch	Same as Week I	Same as Week I	B-ration Breakfast & Supper MCI Lunch
Serving Locations	Onsite and at Remote Sites	Same as Week I	Same as Week I	Same as Week I
Number of Consumers	900	Same as Week I	Same as Week I	Same as Week I
Mess Gear	Std Mess Kit	Disposable	Disposable	Disposable

It is important to note that any experiment has its limitations and Camp Pendleton was no exception. Because of the extended period of operation and the need for a large customer population (900), it was necessary to call on the Infantry Training School to provide up to 300 consumers twice daily. Therefore, the experiment location had to be within 10 minutes marching distance of the School. This precluded the possibility of relocating any of the system during the experiment if a constant workload was to be maintained.

Data Collection Requirements

A variety of data were required to assess the overall performance of the three systems being evaluated. The major types of data that were collected during the experiment included:

Work Sampling - Work Sampling data were collected for all personnel assigned to each system. These data were collected to provide the basis for determining the most reasonable staffing levels for different worker categories for each of the three systems.

Sanitation - During the experiment, microbiological and food temperature data were gathered to measure kitchen and food preparation, and food handling performance. Microbiological data were also gathered concerning quality of sanitation, i.e., cleaning of pots, pans, utensils, and mess kits, where applicable. This information provided a data base for use in comparing the sanitation performance of the XM-75 and XM-76 systems with the conventional Marine Corps system.

Food Acceptance - All consumers at Camp Pendleton were supplied two hot meals daily with the noon meal being an MCI. Consumer surveys designed to measure food quality and quantity and serving temperature were administered throughout the experiment.

Mess Equipment - Surveys were administered to the consumers which were designed to measure customer preference and the advantages and disadvantages associated with the standard metal gear, disposable trays, utensils, and paper cups.

Human Engineering - These surveys were administered to the food service workers to measure their attitudes concerning a number of performance characteristics such as working environment, adequacy of work space, equipment, and equipment layout. Also, a human factors engineering analysis was performed.

Results and Conclusions

Based on the data and information gained through the experiment the following results and conclusions are offered:

1. The overall performance of the XM-75 system was superior to the XM-76 Multiple Mobile Kitchen Trailer primarily due to workspace design problems experienced with the XM-76. Both of the new systems were superior to the standard Marine Corps system which served as the control.

2. The XM-75 and XM-76 Systems are more efficient than the control system and provide the potential for a net reduction of 4 cooks and 5 messmen as compared to the conventional Marine Corps Battalion Kitchen. This represents an overall 24% reduction in the staffing level.

3. Army personnel savings with either the XM-75 or XM-76 systems would amount to 15 cooks and 10 KP's as compared to company level feeding for mechanized infantry maneuver battalion. This represents an overall 49% reduction in the staffing level.

4. The quality of sanitation with the standard Marine Corps system was very difficult to control and on two occasions was unacceptable having Aerobic Plate counts of over 300 organisms per gram.

5. The quality of sanitation with the XM-75 and XM-76 systems far exceeded that of the control system with Aerobic Plate counts of 100 organisms per gram or less.

6. Food service workers considered the XM-75 system to be far superior to either the XM-76 or control systems.

7. Consumer acceptance ratings were uniformly high for all three systems with no single system being significantly better when serving A-ration meals.

8. The B-ration meals did not significantly reduce workload as compared to the A-ration meals, providing only a 2.7% reduction in preparation labor.

9. Consumer acceptance ratings for B-ration meals were significantly lower (2 points on a 9 point Hedonic Scale) than for A-ration meals.

10. The use of disposable trays in place of mess kits is much preferred by consumers and reduces messmen staffing by two personnel.

11. The human factors analysis indicated that the control system suffered from poor working environment, inadequate equipment and insufficient workspace while the major problem with the XM-76 concerned workspace layout. The most serious shortcoming of the XM-75 was a need to increase the length of the kitchen shelter.

CHAPTER III

DESCRIPTION OF EXPERIMENTAL SYSTEMS

During the experiment the three battalion level field feeding systems were evaluated in the following order:

Standard Marine Field Kitchen (Control)
XM-75 Field Kitchen (XM-75)
Multiple Mobile Kitchen Trailers (XM-76)

Each system was operated for five consecutive days and only one system was operated at a time. Various types of data were collected on each system for comparative evaluation purposes. To simplify the evaluation certain systems parameters were fixed and were not allowed to vary from system to system. The fixed system parameters were the food service workforce (except for the reduced staffing with the experimental systems), the menu, and the customer load. These parameters are discussed below.

Fixed Parameters

Food Service Workforce: The control system was operated with a normal authorized workforce consisting of 16 food service personnel and 20 messmen. By contrast, the XM-75 and XM-76 systems were staffed at a reduced level of 12 food service personnel and 15 messmen due to anticipated increases in productivity. This increased productivity was due to the introduction of new items of equipment and labor saving devices.

Menu: One five-day menu was designed for use with all systems during the experiment during the first three weeks of the experiment. The menu consisted of high preference, low labor items suitable for field use. Each system was operated for one menu cycle. By utilizing the same menu with each system, the effect of one significant variable on system performance, the menu, could be eliminated from consideration during any comparative evaluation. During the last week of the experiment a three-day B-ration menu was utilized to obtain comparative data on workload and consumer acceptance relative to the A-ration menu.

Customer Load: During the experiment each system provided two hot meals per day, breakfast and dinner. To simplify the comparative evaluation by eliminating the effect of varying customer load, food for 900 troops was prepared by each system for each meal, 300 for onsite feeding and 600 for remote site feeding. Exceptions were Monday breakfast and Friday dinner when troops in the field were not available for feeding. The food for six hundred individuals was packed into insulated food containers and transported to the field via 2-1/2 ton trucks for serving individuals away from the kitchen site. Food for the remaining 300 individuals was retained at the kitchen site for serving those individuals in the kitchen area.

Control System

The standard Marine battalion field feeding system represented the control system and was operated during the first week of the experiment. The system utilized only field equipment authorized by Marine Corps Table of Organizations (TO), with a few minor exceptions. A description of each of the major elements is presented below, and an exterior view is depicted in Figure 1.

Kitchen: The kitchen was housed in the standard field shelter, the General Purpose (G.P.) Medium Tent which measured 16'W x 32'L. This shelter is designed for widespread general use and has some serious deficiencies when used as a kitchen shelter; notably poor ventilation, inadequate workspace and insufficient entry/exit ways to support the heavy traffic. The only major items of equipment located within the kitchen shelter were ten field ranges, two stainless steel work tables, and one commercial bakery rack. The work tables, not a standard field item, were utilized in place of standard field tables which could not be obtained at the time. The equipment as laid out in the G.P. Medium Tent is depicted in Figure 2.

Serving Line: A second G.P. Medium Tent housed two serving lines. This shelter was set up alongside and parallel to the kitchen shelter. The serving lines consisted of insulated and other containers placed on top of field range mount-out boxes (used for overseas shipment of food service equipment). Two field ranges, one on each line, were also set up for cooking eggs at the breakfast meal. Dinner salads were also prepared in this tent. The layout of equipment in the serving shelter is depicted in Figure 2.

Sanitation and Storage Center: A third G.P. Medium Tent was utilized for sanitation of pots and pans and to store the non-perishable ration components (usually on pallets). All items which required washing were carried to this tent and placed on pallets or on the ground. Two wash lines consisting of three GI cans were located in the tent. Each line contained one can for washing, another for rinsing, and a third for sanitizing dips. Hot water was provided by four GI cans with immersion heaters located outside the tent. The water was carried inside the tent in 10-and 15-gallon pots.

Messgear: During operation with the control system standard metal mess kits were utilized by all individuals served at the kitchen site. Two GI cans with immersion heaters (predips), one for each line, were set up outside the serving tent for heating and sanitizing the metal mess kit before being served. Two mess kit wash lines were also set up to wash the mess kits after each use. Each wash line consisted of three GI cans with immersion heaters. The first can contained soapy water for washing the mess kits while the second and third contained plain hot water for rinsing and sanitizing purposes. Individuals scraped excess food waste off the mess kit into a GI can located at the beginning of each mess kit wash line before proceeding through the line. In addition, two additional GI cans with immersion heaters, one for each wash line, were set up for hand washing.

XM-75 Field Feeding System

The XM-75 system was operated during the second week of the experiment. This system utilized both standard and non-standard items of equipment and was designed

Figure 1. Control Kitchen: Exterior View

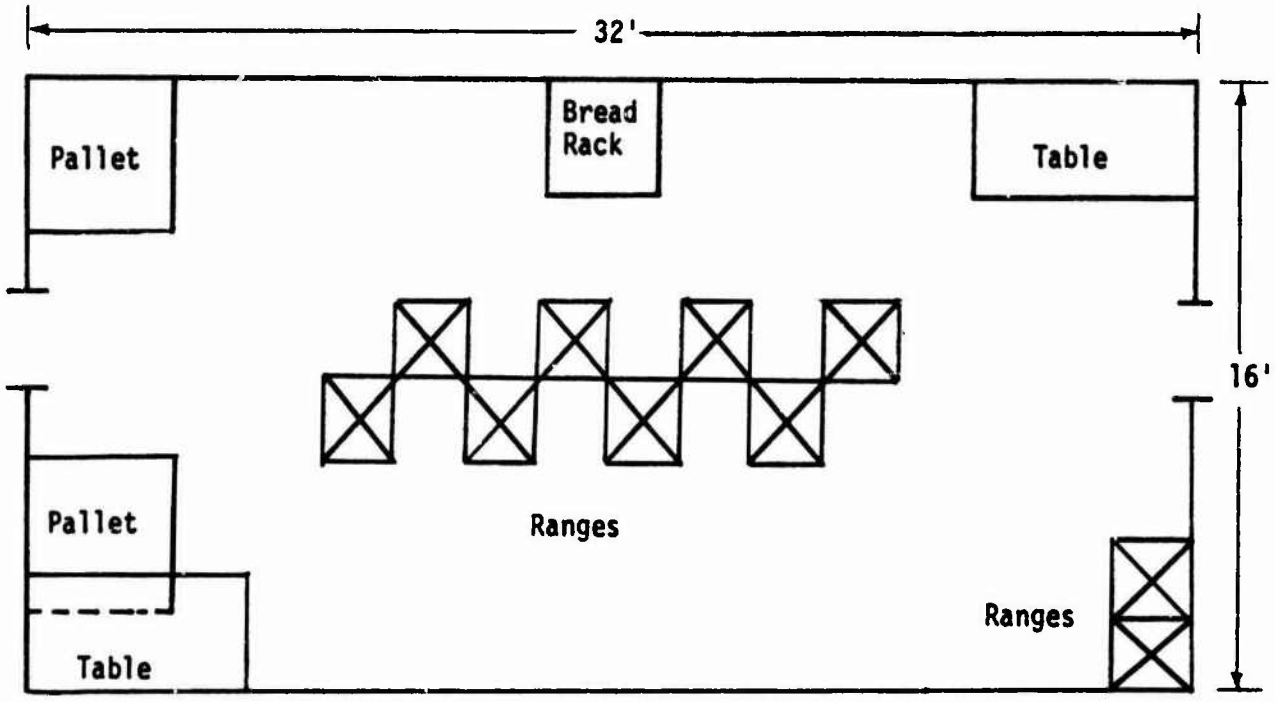
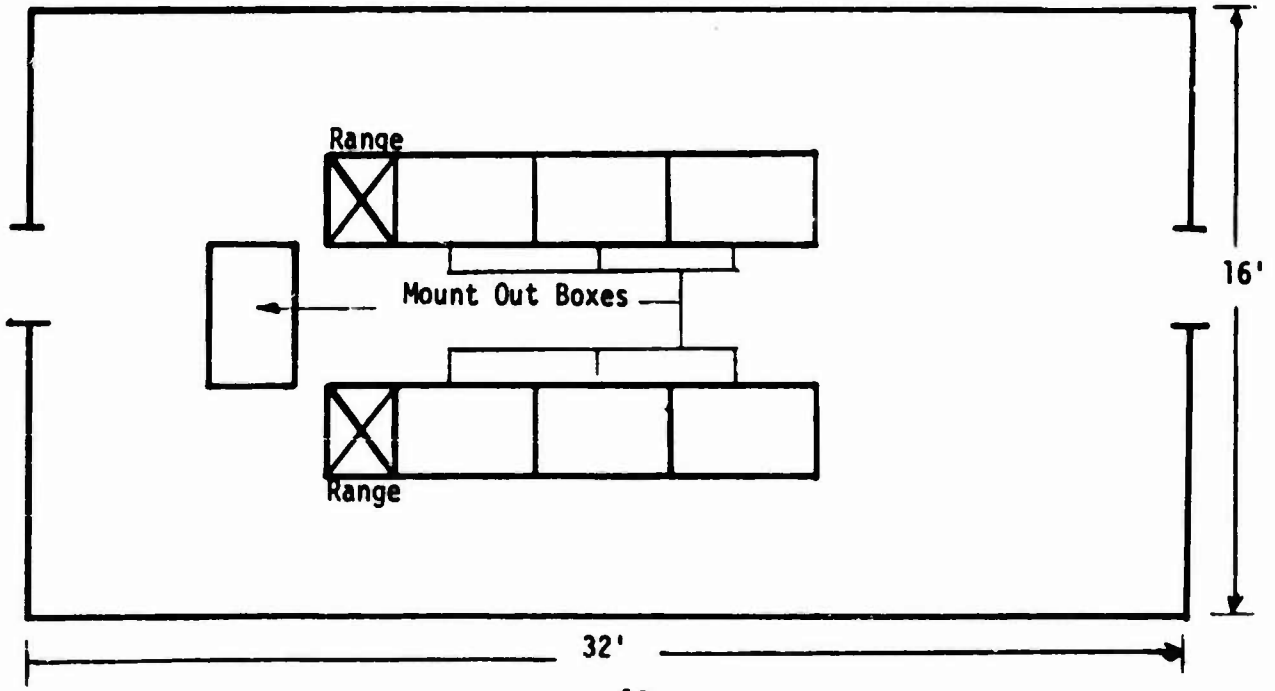


Figure 2. Layout of Control Kitchen (above) and Serving Line (below)



to alleviate some of the major problems and deficiencies associated with the standard Marine Corps system, such as poor ventilation within the kitchen tent, lack of space within the tent for establishing serving lines, lack of suitable equipment for pot and pan sanitation, etc. A description of each of the major elements of the XM-75 is presented below. In addition, a detailed discussion of the performance of the major commercial and non-standard items of equipment employed during the experiment is contained in Appendix A.

Kitchen: The kitchen was housed in a sectional, lightweight, frame-supported shelter. This shelter is basically a standard Army expandable frame type tent modified to provide improved ventilation and access. The shelter consisted of five sections, each 17' W x 8' L, making the complete kitchen shelter 17' x 40'. A total of eight doorways were provided, two at each end and one on each side of both the second and fourth sections. The two door sections had zippered closures and were equipped with screens with velcro closures. The remaining three sections had large permanently screened windows on both sides and were equipped with clear plastic panels with velcro closures for inclement weather. In addition, fabric with velcro closures could be dropped over the windows for blackouts. Window fabric, plastic window panels, doorway fabric, and doorway screens could be rolled up and tied when desired. Each section also had a large screened vent with fabric covering on each side of the roof panel to permit the hot air and gas to escape. The fabric covering on the vents was adjustable to provide the desired amount of ventilation. Environmental and blackout protection was provided by a large fly which was approximately 12 inches above the shelter and which extended beyond each end of the shelter. An exterior view of the XM-75 Kitchen is pictured in Figure 3. A listing of the kitchen equipment for all three systems is provided in Table 2 while a layout of the XM-75 is depicted in Figure 4.

TABLE 2. MAJOR ITEMS OF KITCHEN EQUIPMENT

Items	Control	XM-75	XM-76
Griddles	-	4	3
Steam Tables	-	4	-
Tables, Stainless Steel	2	9	2
Field Ranges	12	10	6
M-2 Burners (Total)	12	18	9
Bakery Rack	1	1	1
Cabinets/Ice Chests	-	-	6
Meat Slicer, Electric	-	1	1
Salad Cutter, Electric	-	1	1
Tomato Wedger	-	1	1
Can Opener, Electric	-	1	1
Cooking Racks	-	-	12

Two serving lines were set up lengthwise in one-half of the shelters, occupying two complete sections and extending slightly beyond the end but not beyond the fly.

Figure 3. XM-75 Kitchen: Exterior View

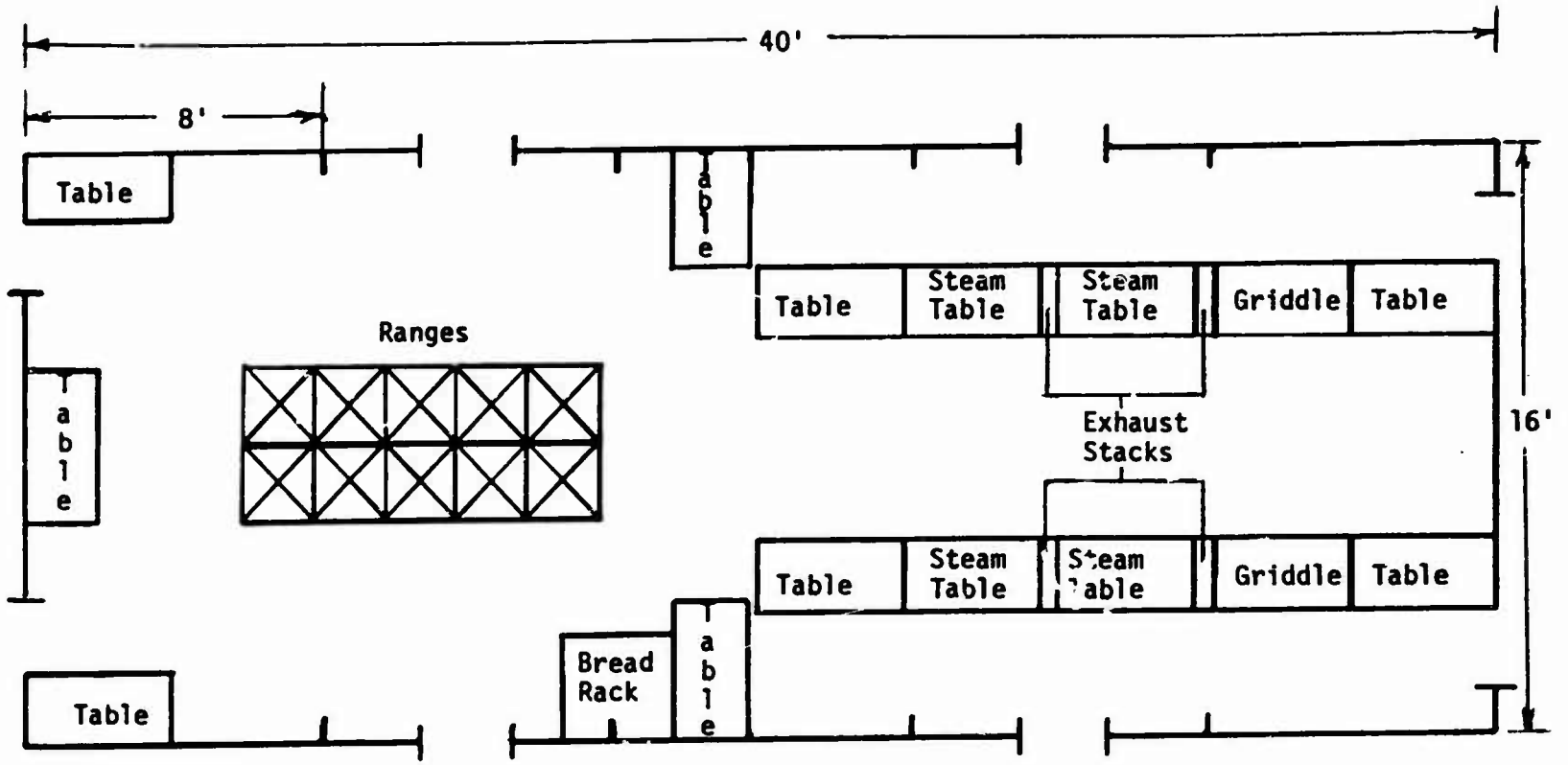


Figure 4. Layout of XM-75 Kitchen

Customers entered through the side doorways, proceeded through the serving line, and existed through the front doorways. Each serving line consisted of three stainless steel tables, one griddle, and two steam tables. All components of the serving line were approximately 2' W x 4' L. The first item of equipment in the serving line was a three shelf table with the top shelf being a half shelf. This was followed by a two shelf stainless steel table, then two stainless steel steam tables, one griddle, and finally another two shelf stainless steel table. Each steam table was designed to hold two squarehead pans and was heated by M-2 burners. The griddle was heated by two M-2 burners. Between each pair of griddles/steam tables was an exhaust stack which extended approximately 42 inches above the griddle and steam table tops. These exhaust stacks created a draft which exhausted most of the hot air and fumes near the open vents above, thus lowering the temperature and level of fumes within the kitchen area.

The remainder of the shelter was utilized for food preparation. Ten ranges were set up for cooking and baking purposes, while three stainless steel work tables were provided for food preparation. One commercial bakery rack was used for storing bread and other baked items.

Four labor saving devices (an electric can opener, electric meat slicer, electric vegetable cutter, and a manual tomato wedger) were also provided with the XM-75 system.

Sanitation Center: A sanitation center, for the washing and sanitizing of pots, pans, insulated food containers, utensils, and other items of equipment, was provided as part of the XM-75 system. The sanitation center was also housed in an expandable frame type tent which consisted of two 17' W x 8' L sections of the same design as those used in the kitchen shelter. The equipment used is listed in Table 3 and depicted in Figure 5.

TABLE 3. XM-75/76 SANITATION CENTER EQUIPMENT LIST

Item	Quantity
Field Kitchen Sink	4
Drain Table	3
Wire Shelving	5
M-2 Burners	4
Hot Water Heater (Outside)	1
Pump With Necessary Hoses (Outside)	1
Sump Pump (Outside)	1

Four non-standard stainless steel field sinks were set up to provide for prewashing, washing, rinsing, and a sanitizing rinse. Metal cradles were used to support the sinks and hold M-2 burner units used for maintaining water temperature. The wash line included three stainless steel work tables, which were connected to the sinks. The sinks, 24" L x 25" W, were large enough to immerse the largest cookware (the 15-gallon pot) currently in the system. In addition, five sets of wire shelving were set up in the sanitation center for storing and drying sanitized items.

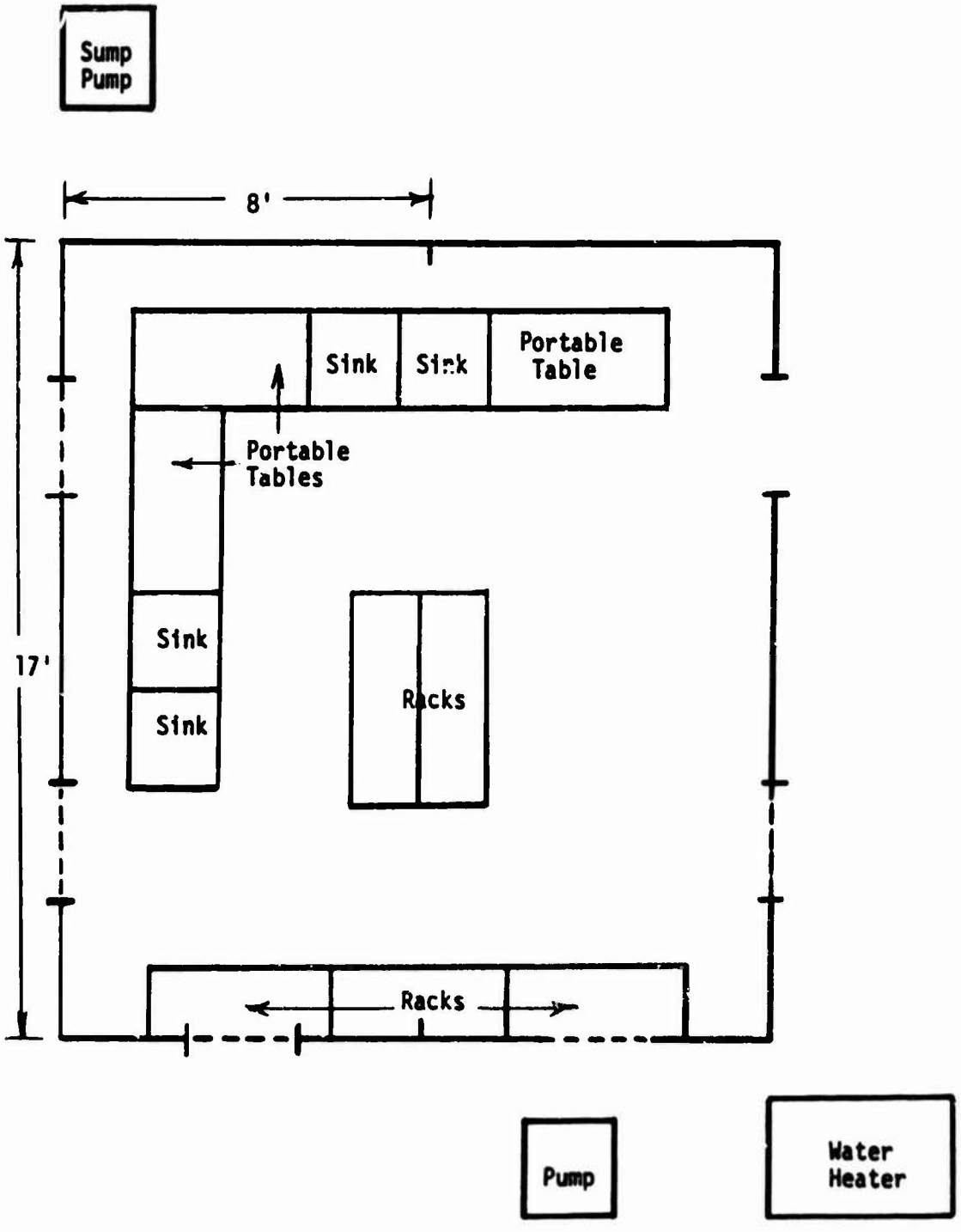


Figure 5. Layout of Sanitation Center

A standard water heater with pumps from an Army laundry and shower unit was used to provide a continuous supply of 180°F water. One of the pumps was used to transfer cold water directly from a 400-gallon water trailer, and automatically recirculate it between the boiler and a GI can used as an expedient hot water holding tank. As required, hot water was then pumped into the sinks. Each sink was equipped with a drain hose, which would normally be drained directly into a nearby soakage pit. However, due to local environmental restrictions, waste water had to be pumped by a sump pump into a holding tank and periodically transported to the installation waste disposal facility.

Storage Shelter: A 16'W x 16'L shelter of the same design as the sanitation shelter was provided for the storage of non-perishable subsistence items and miscellaneous supplies. Supplies were placed on wooden pallets.

Mess Gear: Disposable mess gear was utilized with the XM-75 system which eliminated the need for setting up and operating mess kit wash lines. The disposable mess gear consisted of five-compartment, fiber-board trays; 10-ounce paper cups, and individual accessory packets containing a napkin; plastic knife, fork, and spoon; and miscellaneous condiments.

XM-76 Multiple Mobile Kitchen Trailer System

The XM-76 system was designed to evaluate the feasibility and effectiveness of employing three Mobile Kitchen Trailers(MKT's) as a battalion kitchen. It was operated during the third week of the experiment. The major difference between the XM-75 system and the XM-76 system was the kitchen itself. All other major elements such as the sanitation center, storage shelter, labor saving devices, and mess gear remained identical.

Kitchen: The MKT, designed to support company level feeding, is a self contained trailer mounted field kitchen consisting of standard field feeding equipment packaged in a configuration to allow efficient preparation, storage, and serving of A or B-ration type meals. The MKT is designed and equipped to provide three hot meals daily for up to 300 individuals. Horizontal expansion of the MKT provides the necessary working area and a serving line. A manually raised roof with fabric sides and screening provides environmental protection. Vents are provided in the roof of the MKT. The MKT utilizes a standard M103A3 trailer chassis and is designed to be towed by a standard 2-1/2 ton tactical vehicle. One MKT, with cooking equipment, weighs approximately 5700 pounds. The major items of equipment provided on a MKT are detailed in Table 2.

The XM-76 kitchen consisted of three MKT's in a T configuration, and connected by a modular aluminum platform having overall dimensions of 12' x 12'. An exterior view is shown in Figure 6. A transitional covering was provided over the platform area. Three sides of the covering were joined to the roof of the MKT's while a fabric covering was provided for and connected to the transitional covering on the fourth side of the platform. Thus, protection from the elements was provided the entire XM-76 kitchen complex.

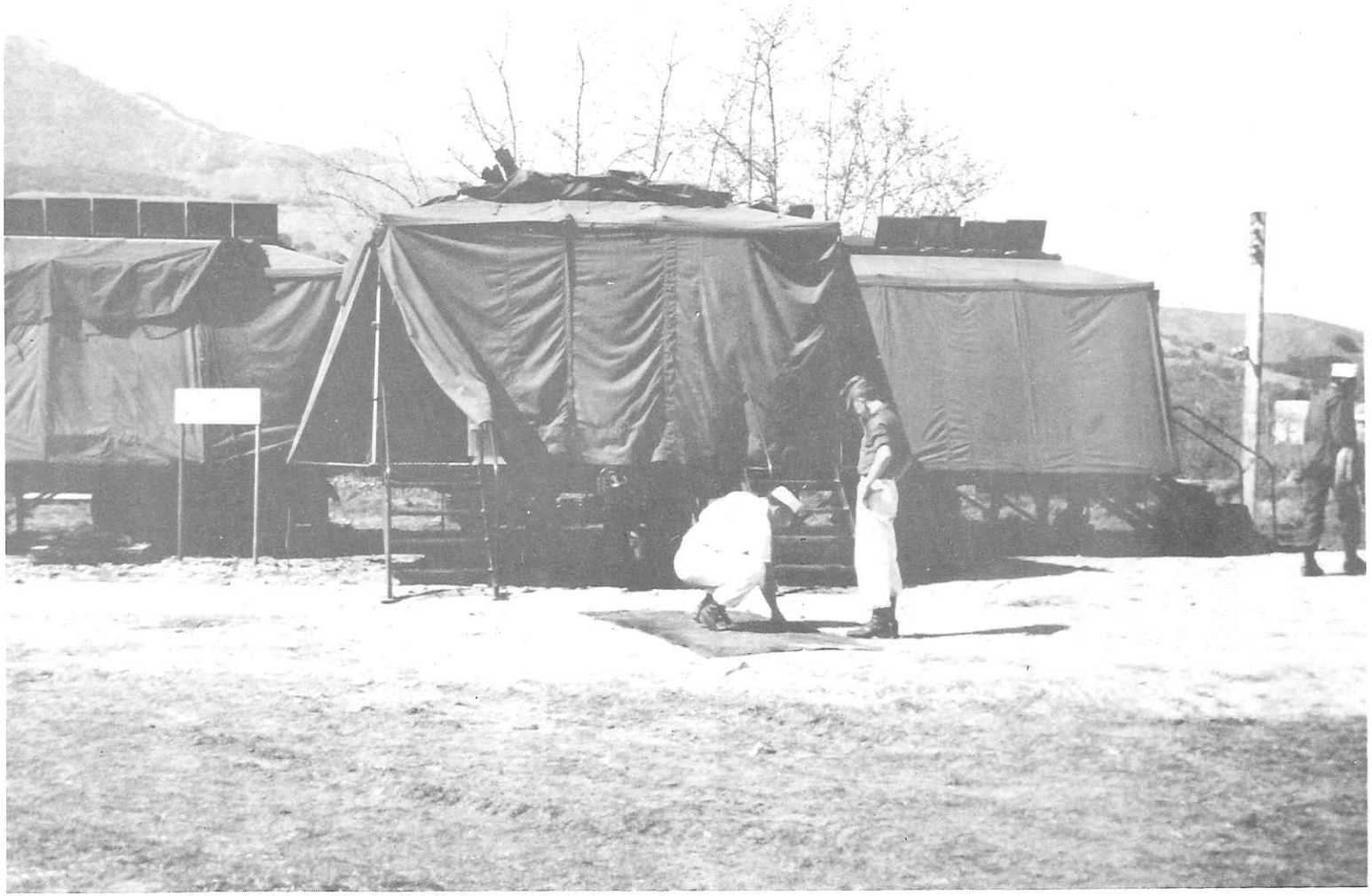


Figure 6. XM-76 Kitchen: Exterior View

The layout of the XM-76 kitchen complex is shown in Figure 7. A total of seven doorways, 2 to each MKT and one on the fourth side of the platform, provided easy access and exit. Stairways were provided for each doorway. Two U-shaped serving lines were set up and utilized to feed those troops subsisting at the kitchen site.

Various labor saving devices such as an electric can opener, electric meat slicer, electric salad making machine, manual tomato wedger, which were provided with the XM-75 system, were also used with the XM-76 system.

Sanitation Center and Storage Shelter and Mess Gear: The sanitation center and storage shelter designed for the XM-75 system was also utilized with this system. The same disposable mess gear utilized with the XM-75 system was also used with this system.

Miscellaneous

Certain data, components, and operating procedures were not part of the evaluation or were the same for each system. A brief discussion on each is presented below.

Dining Tents: Four G.P. Medium Tents were set up for dining purposes. The dining tents were provided solely for the comfort of those dining at the kitchen and were not being evaluated. Garrison dining tables were set up inside the tent.

Electrical Power: Two 30KW generators were used to provide the required electrical power to operate the reefers, lights, water heater and pump, and other labor saving kitchen devices. Only one generator was used at a time, the other serving as backup. The 30KW capacity was much larger than required.

Reefers: Refrigeration was provided with all systems. Two 100 ft^3 reefers (ME-10's) were used with the control system, while a new experimental 400 ft^3 reefer was used with the XM-75 and XM-76 experimental systems. The reefers were not part of the evaluation.

Data: In addition to the data that will be presented as part of this report, additional information and data of a general nature was obtained during the experiment. This information is summarized in Tables 1-5 of Appendix A for purposes of making it part of the record.

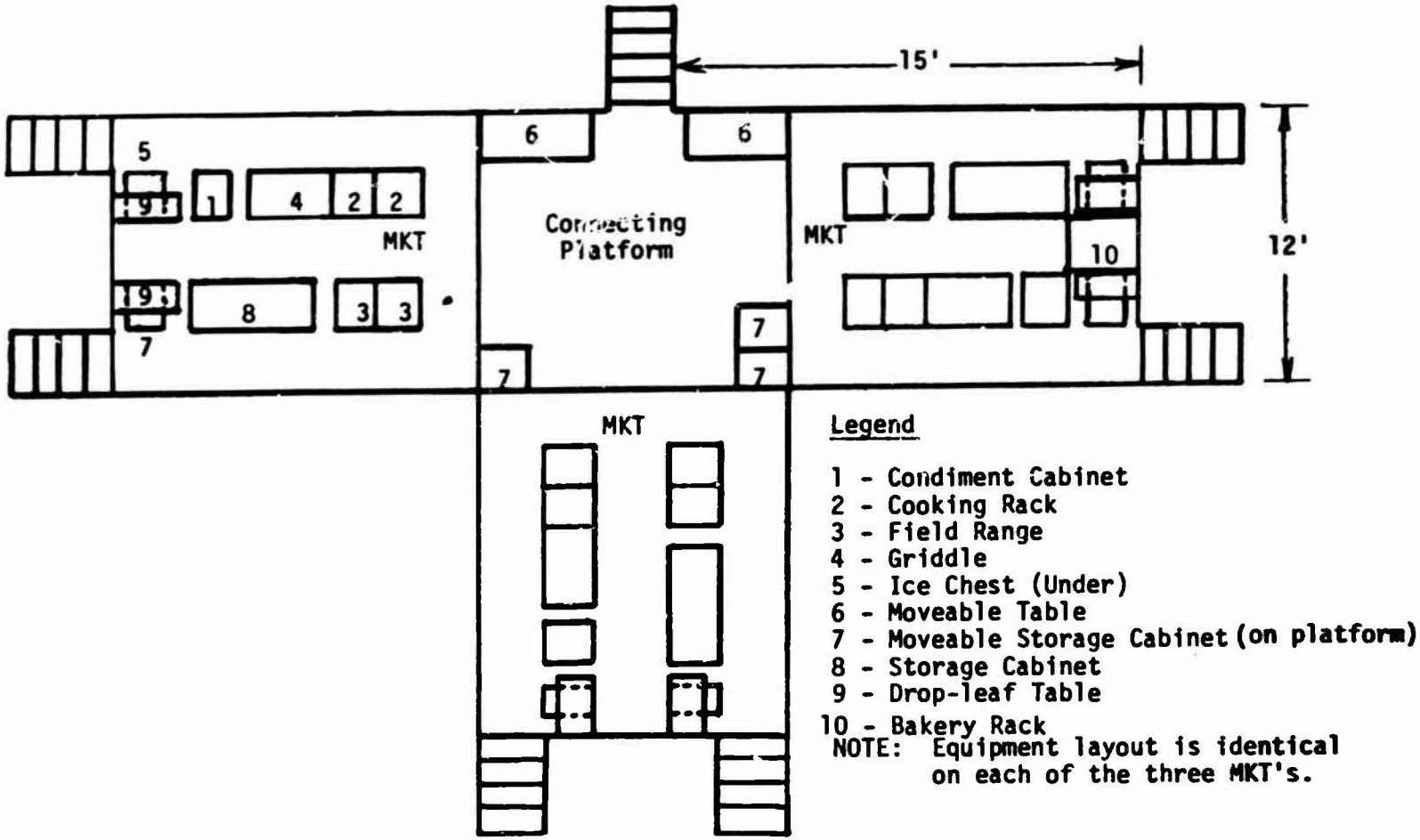


Figure 7. Layout of XM-76 Kitchen

CHAPTER IV

WORK SAMPLING ANALYSIS

The work sampling method of work measurement is used to develop data which can be used to make reasonably accurate decisions as to the required staffing levels for operations which are non cyclic and where many different tasks are performed. During the Camp Pendleton experiment work sampling data were collected on each of the three systems evaluated. These data were utilized to characterize the workload generated by each system and to estimate the staffing requirements to operate each system.

Work sampling consists of taking a large number of observations on individuals performing tasks in a work situation. The task being performed at each observation is recorded. Observations are usually made on a random basis to obtain statistically valid results. However, in non-repetitive situations, observations can be made on a systematic basis without introducing bias, provided the interval between observations is sufficiently small. The latter approach was utilized during this experiment.

The accuracy of work sampling results is dependent upon the number of observations taken. The larger the number of observations, the more accurate the results, that is, the closer the characteristics of the sample approximate what actually occurred. Therefore, the interval between observations was set at five minutes. This interval was considered to be the smallest possible that would still permit accurate data collection. With the five minute interval the absolute accuracy of the work sampling data is within 2.5% with 95% confidence.

Procedures

Work Categories: All individuals assigned to operate each system were classified as belonging to one of three worker categories. The worker categories and the one digit codes for data collection purposes were:

1 - Supervisors
2 - Cooks
3 - Messmen

Bakers were classified as cooks. However, a separate task, denoted baking, was provided; therefore, the number of hours dedicated to baking can be extracted from the data.

Tasks: Fifteen tasks were defined for work sampling data collection purposes. The tasks with their two digit codes and detailed definitions are provided in Appendix B.

Observation Schedule: Each system provided two hot meals daily, breakfast and dinner. The bakers prepared the items on each day's menu during the preceding evening. As a result each system basically operated on a twenty-four hour a day basis. Therefore, work sampling data were collected on an around the clock basis from Sunday evening, when the bakers began preparing Monday's items, to the end of the workday Friday. To minimize tedium, three work sampling data collectors were scheduled for each of two 9-hour shifts (2 AM - 11 PM and 11 AM - 8 PM). One recorded data for the cooks, the second for the messmen, and the third one was on break. The night shift (8 PM - 2 AM) data was recorded by one data collector since it consisted of two bakers, one cook and one messman. Using a 24-hour clock, the data collectors recorded a three digit code for each individual on duty. The form used to record the data is shown in Appendix B.

Data Used

With each system 900 portions, 300 for onsite feeding and 600 for remote site feeding, were prepared for each meal except for Monday breakfast and Friday dinner, when field units had the weekend off. Therefore, to avoid the mixing of data for different feeding levels the work sampling data pertaining to Monday breakfast and Friday dinner were excluded from the analysis. The data included in the analysis covered the period from 1200 hours on Monday to 1200 hours on Friday.

Since the Friday dinner data were not to be included in the analysis, the system being operated changed after the Friday breakfast. For example, on Friday of week I breakfast was prepared with the control system, but dinner was prepared with the XM-75 system. Therefore, prior to the period for which the work sampling data were utilized (1200 Monday - 1200 Friday) the workforce was provided with a one day training period with each experimental system, Friday dinner and Monday breakfast, and a half day training period with the control system.

Method of Analysis

The number of man hours of effort expended on any task by individuals in any worker category while operating any of the systems evaluated can be estimated from the work sampling data. As previously mentioned the interval between observations was set at 5 minutes; therefore, each individual was observed and the activity being performed recorded twelve times per hour while he was on duty. The number of times individuals within a given worker category are recorded as performing a given task during a specified time period divided by 12 estimates the number of man hours of effort expended during the specified time period. For example, if twelve cooks are on duty, then 144 observations would be made in a one hour period. These 144 observations represent 12 man hours of effort. If 42 of these observations denoted cooks cooking then the estimated number of cook man-hours devoted to cooking would be 3.5 (42/12) man-hours. This is the basic type of analyses performed and presented in the remainder of this chapter. The data were analyzed for

each worker category by task, and for each worker category by hour of the day. The following equation shows the calculations performed by task:

$$W_{jk} = \sum_{m=0}^{23} \frac{S_{jkm}}{N_{jm}} \Delta$$

where

j = system number

k = task code

W_{jk} = the average number of man-hours expended daily on task k while operating system j

m = hour of the day

S_{jkm} = for system j, the number of observations of task k recorded during hour m

N_{jm} = number of days during which hour m was sampled for system j

Δ = interval between observations in hours; 5 minutes = 5/60 = 1/12

One exception to processing data for the three systems separately was task 11, denoted as other productive time. Task 11 was used to record supervision, administrative work, and any other productive time not covered by another task. Some activities recorded under task 11 were:

Moving equipment from one system to another.

Work done, such as arranging equipment, on another system not being utilized for cooking.

Digging trenches to prevent flooding during inclement weather.

Taking someone or being taken to sick bay.

Many of these activities were unrelated to direct kitchen work and dependent upon non-system factors. Therefore, this task was averaged by worker category for all three systems, and appears as the same figure for each system in the data tables.

Analyses by Task

Combined Workforce: Table 4 summarizes how the combined workforce allocated their time while operating each system. Table 1 of Appendix B contains the data by task. Figure 1 of Appendix B presents this same data in bar graph form and figure 2 of Appendix B presents it by worker

category. The combined workforce expended 293.1 productive man-hours on a daily basis to operate the control system and only 206.6 and 203.9 productive man-hours to operate the XM-75 and XM-76 systems. The number of productive man-hours expended to operate each experimental system were not significantly different and represented a 30% decrease from the number of productive man-hours expended to operate the control system. Thirty percent, 29% and 36% of the workforce's

TABLE 4. COMBINED WORKFORCE: AVERAGE NUMBER OF MAN-HOURS EXPENDED DAILY

	Control	XM-75	XM-76
Total Productive	293.1	206.6	203.9
Non-Productive			
Idle	99.8	63.8	88.1
Absent	26.4	21.3	29.1
Total Non-Productive	126.2(30%)	85.1 (29%)	117.2 (36%)
Total Available	419.3	291.7	321.1
Eating Meals	34.7	21.5	35.6

available time (excludes meal periods) was classified as non-productive, that is idle or absent, while operating the control, XM-75 and XM-76 systems respectively. Previous studies of food service operations have indicated that 25% to 30% non-productive time is typical. This suggests that the amount of available time provided was appropriate while operating the control and XM-75 systems but excessive while operating the XM-76 system. It is interesting to note that the level of effort (productive man-hours) required to operate each experimental system was approximately the same. However, the increase in available man-hours provided while operating the XM-76 system (which was the result of two additional messmen) as compared to the XM-75 system significantly increased the non-productive time. Since the length of the workday was approximately the same while operating each experimental system, this implies that the two additional messmen employed by the XM-76 system were not required and that the XM-76 system should have operated at the same staffing levels utilized for the XM-75 system (see Chapter V). A discussion on the amount of time expended by the combined workforce on each major task while operating each system is presented below:

(1) Food Preparation - On the average, the combined workforce expended 28% fewer man-hours on food preparation and baking while operating each experimental system than they did while operating the control system. This labor savings can be attributed to the fact that cooking and serving was consolidated under one shelter, to the improved cooking equipment and to labor saving devices provided with the XM-75 and XM-76 kitchens.

(2) Packing Food for the Field - The amount of time dedicated to this task was basically the same for all three systems and ranged from 14.2 to 14.9 man-hours per day. This was expected since food for 600 troops was sent to the field for each meal by each system and no special items of equipment were provided for this operation with any of the three systems.

(3) Serving - On the average the combined workforce expended 34% fewer man-hours on serving while operating the XM-75 and XM-76 system than were expended while operating the control system. This large savings can be attributed to the consolidation of the cooking and serving functions under one shelter with each experimental system. With the control system these two functions were performed in two separate shelters. This consolidation eliminated the need to transport food and containers back and forth between two separate shelters as required with the control system.

(4) Kitchen Sanitation - Kitchen sanitation remained fairly constant for all three systems, ranging from 27.3 - 34.2 productive man-hours per day. The XM-76 showed the maximum kitchen sanitation effort, which can be attributed to the requirement of scrubbing the deck of the multiple MKT units and platform.

(5) Pot and Pan Sanitation - On the average, the combined workforce expended 47% fewer man hours on pot and pan sanitation while operating the XM-75 and XM-76 system than were expended while operating the control system. This large savings can be attributed to the new sanitation center provided with the experimental systems. The average number of productive man hours expended on this task declined by 27.8 man-hours, which is equivalent to approximately 3 man days of labor.

(6) Mess Kit Laundry Line - For the mess kit laundry line 17.2 man-hours of productive time were expended. This represents only the workload generated by two and sometimes three mess kit washlines which were set up at the kitchen site. For the XM-75 and XM-76 kitchens, the use of disposable mess gear eliminated the need for the mess kit laundry line.

Supervisors: Table 2 of Appendix B summarizes how the supervisors allocated their time while operating each system. Supervisors averaged 10.5, 11.4 and 11.3 productive man-hours on a daily basis while operating the control, XM-75, and XM-76 systems respectively. Approximately 90% of the supervisors productive time was considered as other productive which includes supervision and administrative work. The supervisors averaged less than one productive hour per day on all other productive tasks combined. Approximately 42% of the supervisors available time was classified as productive with the remaining 58% being classified non-productive.

Cooks: Table 3 of Appendix B summarizes how cooks/bakers expended their time while operating the control, XM-75 and XM-76 systems respectively. Twenty-eight percent, 21%, and 30% of cooks/bakers total available time was classified as non-productive while operating each system respectively. As expected, cooks/bakers spend more productive time on food preparation/baking than on any other tasks. Between 45% and 50% of the cooks/bakers total productive time was expended on these two activities.

The decrease of the number of productive man-hours expended by cooks/bakers on a daily basis to operate the XM-76 system as compared to that expended while operating the XM-75 system is due to a shift in workload from the cooks to the messmen. Three productive tasks -- food preparation, serving, and packing food for the field, showed a decrease in cooks productive time from the XM-75 to the XM-76, while the same three tasks showed an increase in messmen's productive time from the XM-75 to the XM-76. This shift in workload may be due to the way the supervisor assigned workload or increased confidence by the cooks since they were going through the same menu for the third time.

Messmen: Table 4 of Appendix B summarizes how messmen allocated their time while operating each of the three systems. Messmen averaged 159.1, 96.0, and 106.7, productive man-hours on a daily basis while operating the control, XM-75, and XM-76 systems respectively. Twenty-nine percent, 31% and 38% of the messmen's total available time was classified as non-productive while operating each system respectively. The increase in non-productive time for the XM-76 system suggests that the two additional messmen utilized with the XM-76 system, as compared with the XM-75 system, were not necessary. As expected, messmen expended more time on pot and pan sanitation than any other task, averaging 58.7, 31.8, and 30.2 man-hours on a daily basis. The introduction of disposables relieved the messmen of an additional 16.3 productive hours. A minimum total labor savings of 43.2 productive hours was realized with the combined use of the sanitation center and disposables. This labor savings is 27% of the total productive labor requirement for messmen which was measured during operation of the control system.

Analysis by Hour of the Day

Figures 8 and 9 depict the hourly distribution of productive time of the cooks and messmen respectively, for the three kitchen systems. The actual data for these graphs are included in Tables 5 and 6 of Appendix B. An analysis of supervisory time is not presented since they are not always available at the kitchen site and arrange their own workday to fulfill whatever demands the kitchen places upon them.

Cooks: The maximum number of productive hours expended by cooks during any hour of the day was 8.8, 8.0, and 6.4 hours for each system, respectively. The two peak periods of the day for cooks were 0300 - 0800 and 1300 - 1800 for the three systems. This would be expected, as these two periods represent the hours of the day dedicated to meal preparation and serving. A night cook, who started breakfast preparation, and two bakers were usually on from 2000 - 0200 of the next day. These three were very busy as productive time during these hours was usually above 2 hours. Productive time from 0900 - 1200 can be attributed to kitchen sanitation from breakfast and the securing of supplies for the evening meal.

Messmen: The maximum number of productive hours expended by messmen during any hour of the day was 12.2, 6.6, and 7.5 man-hours for each system respectively. The peak periods for messmen were 0400 - 1000 and 1300 - 1900. During the hours of 2000 - 0200, a night messman was assigned to the kitchen.

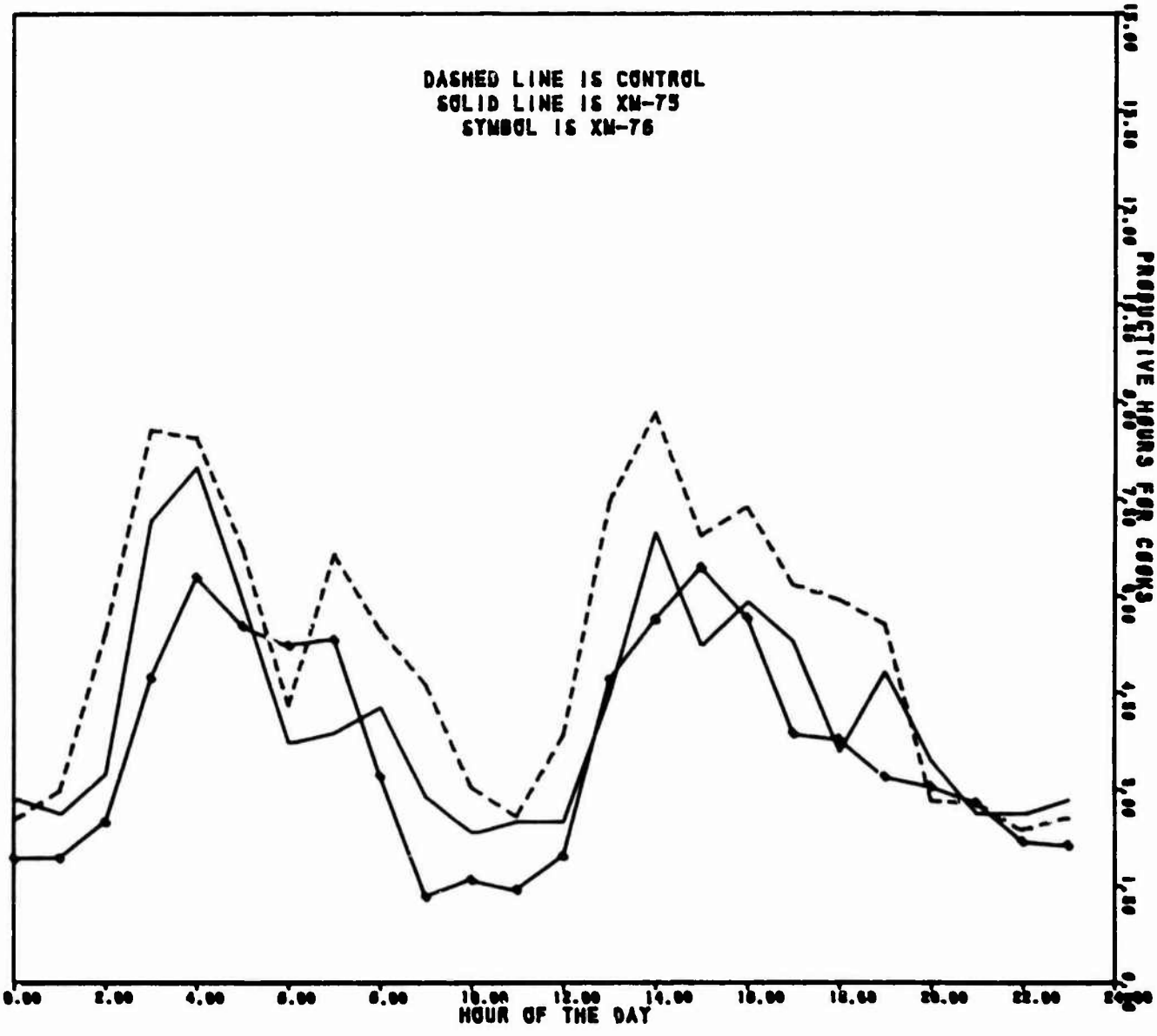


FIGURE 8. COMPARISON OF COOKS PRODUCTIVE TIME BY SYSTEM

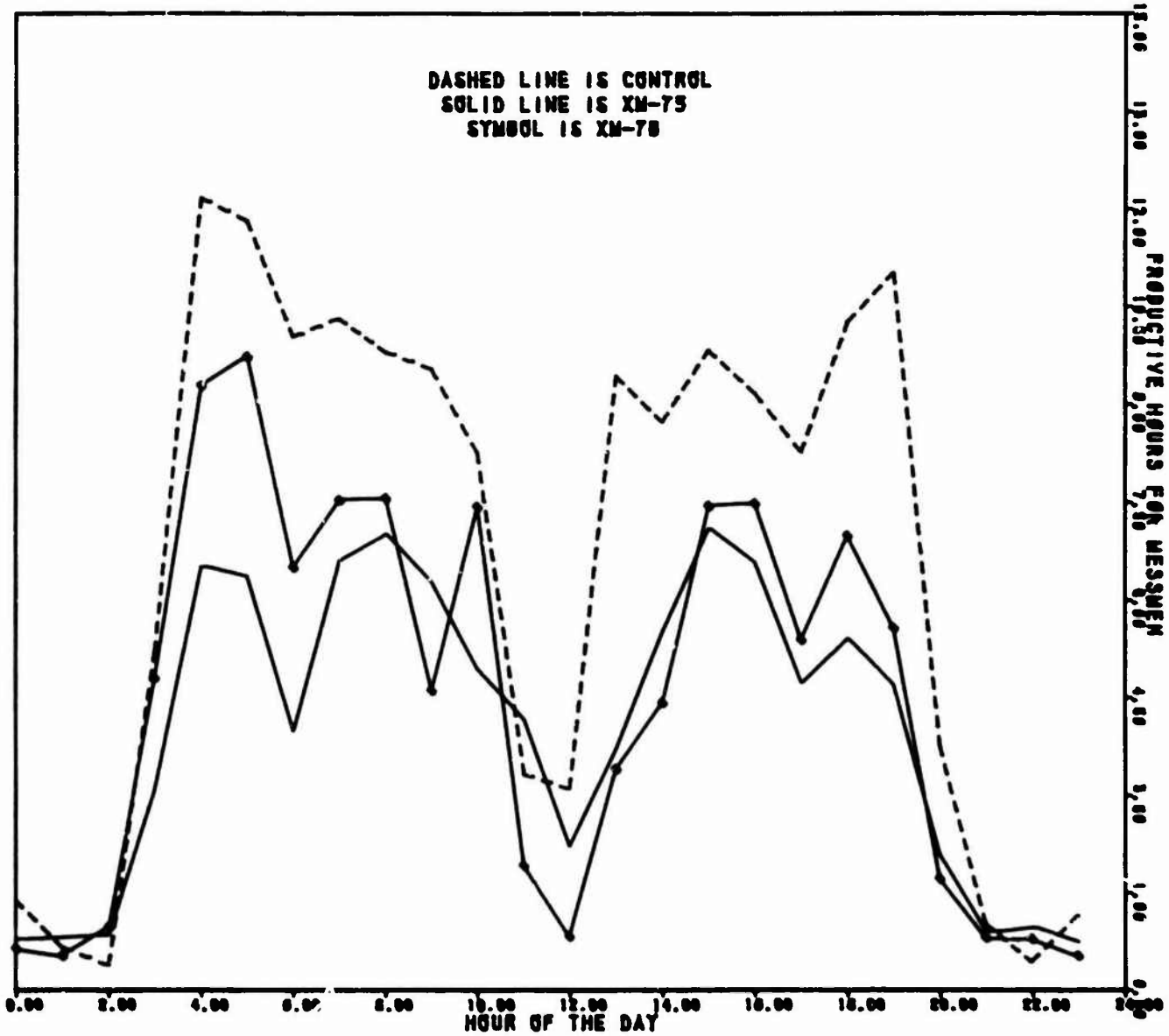


FIGURE 9. COMPARISON OF MESSMEN PRODUCTIVE TIME BY SYSTEM

Productivity

Productivity in food service operations is frequently defined as the number of meals prepared per man-hour of labor expended. The work sampling data provides a good estimate of the number of productive man-hours required to operate each system. However, since the design staffing levels utilized were "best estimates" the number of non-productive hours expended may be low due to understaffing or high due to overstaffing. Therefore, to calculate the productivity of each system the number of scheduled man-hours required to yield the number of productive hours expended will be estimated. To calculate productivity the following assumptions are made:

Scheduled Hours/Person = 12 hours

Available Hours/Person = 11 1/3 hours (excludes two 20 minute meal breaks)

% Available Hours which are Productive = 75% (see Chapter V)

Then:

$$\text{Available Hours Required} = \text{Productive Hours}/0.75$$

and

$$\text{Scheduled Hours Required} = \text{Available Hours Required} \times \frac{(12)}{11\ 1/3}$$

and

$$\text{Productivity} = \frac{\text{Number of Meals Prepared}}{\text{Scheduled Hours Required}}$$

As shown by Table 5, the productivity of the XM-75 and XM-76 achieved a 43% improvement over the conventional system, providing a capability of producing nearly an additional 2 meals per man hour.

TABLE 5. PRODUCTIVITY

System	Scheduled Hours Required/Day	Productivity * (Meals/Man-Hour)
Control	414	4.4
XM-75	292	6.2
XM-76	288	6.3

* Based on serving 1800 meals per day.

A-Ration Versus B-Ration

This section presents a comparison of the average work hours expended by the combined workforce for the preparation and serving of an A-ration and a B-ration.

The major differences between the two were the use of perishable versus non-perishable entrees and lack of salads in the B-ration menu. Many components of the rations were the same (e.g., canned vegetables, dehydrated mashed potatoes, etc.).

During the fourth week of the experiment, five meals were prepared using B-ration items. These meals were prepared on both the XM-75 and XM-76 systems to ascertain if any differences existed in labor savings with the experimental systems when preparing a B-ration meal. The work sampling data for the XM-75 and XM-76 systems were averaged for each ration. The work sampling data for the combined workforce is presented in Table 6.

TABLE 6. DAILY AVERAGE MAN-HOURS FOR COMBINED WORKFORCE: A VS. B-RATION

Task	A-Ration*	B-Ration*
Food Prep	39.7	42.0
Baking	11.7	15.0
Pack Food for Field	14.3	10.4
Serving	18.3	17.6
Supply	7.8	15.8
Kitchen Sanitation	30.8	28.0
Pot & Pan Sanitation	31.4	23.0
Laundry Line	0.0	0.0
M-2 Burners	18.9	15.6
Other Productive	32.4	32.4
Idle	76.0	117.0
Absent	25.2	25.7
Meal Break	28.6	28.0
Rest Break	61.5	33.4
Delivering to Field	37.2	30.5
Total Productive	205.3	199.8
Grand Total	433.7	477.1

* Average data for both XM-75 and XM-76 systems.

Although there are small variances in the individual tasks, the productive total of daily average work hours for the A and B-rations is basically the same, differing by only 2.7%.

Conclusions

The following conclusions can be made from the work sampling analysis:

1. There is no significant difference in labor requirements for the XM-75 or XM-76 systems.

2. Both the XM-75 and XM-76 systems reduce labor requirements over the conventional system by 30%.

3. The use of disposable mess gear reduced productive labor requirements by over 17 man-hours per day.

4. The use of the experimental sanitation center reduced pot and pan sanitation time by 47% as compared to the conventional method.

5. There was no significant difference in total labor requirements between an A and B-ration.

CHAPTER V

STAFFING

The major objective of this experiment was to determine the required staffing levels of the experimental battalion kitchens so that these levels could be compared against the standard staffing levels of the company level kitchen system of the Army and the standard battalion level kitchen of the Marine Corps. The well known work measurement technique of work sampling was used to determine the required staffing for each of the three kitchens operated in this system. The correct application of this technique requires that staffing levels used at the start of the experiment be rigorously defined based upon all available information and data. These levels should be good estimates of the required staffing levels. As the experiment progresses, it is normal to expect that pressures from participating personnel could require the addition of additional workers. If these additions are minimized and if the original staffing level estimates were good estimates, the work sampling and production data collected during the experiment will allow accurate calculations of the final required staffing levels for each kitchen.

Due to the introduction of new or improved items of equipment, a more efficient layout of cooking and serving areas, the use of disposables, and the addition of various labor-saving devices, it was expected that the total workload (productive man-hours of effort) required by both experimental systems would be considerably lower than the control system. Therefore, the staffing levels designed for use with the experimental systems were significantly lower than the staffing levels authorized for use with the control system.

The rationale for defining and establishing the staffing levels of all three kitchens, which are detailed in Table 7, is discussed below.

TABLE 7. EXPERIMENT DESIGN STAFFING LEVELS

	No. of Individuals	
Worker Category	Control	XM-75/76
Supervisors	2	2
Bakers	2	2
Cooks	12	8
Messmen	20	15
Total	36	27

Designed and Planned Staffing Levels

Supervisors: A total of two food service supervisors were planned for all three systems during the experiment. This staffing level is representative of the staffing which would be found in a typical Marine Corps battalion field feeding system when supporting approximately 900 troops. The rationale for keeping the supervisory staffing level the same for the new systems was based on the consideration that the new systems would not significantly change the required supervisory function or workload.

Cooks and Bakers: The staffing level for the control system was planned to include two bakers and twelve cooks. This was representative of the staffing for a typical Marine Corps field kitchen supporting 900 individuals. The number of bakers projected as required and planned for the experimental systems remained the same since the bakers were not provided any new labor saving equipment. The experimental systems were staffed with eight cooks which was a reduction of four cooks from the staffing of the control system for the following reasons: (1) In both the XM-75 and XM-76 systems the food preparation and serving function workload was significantly reduced because of the consolidating of these function within one shelter whereas with the control system these two functions were performed in two separate shelters. (2) The experimental systems were equipped with labor saving items of equipment, such as griddles, an electric meat slicer, salad making equipment (electric salad cutter and tomato wedger), a hot water heater with pumps and new field sinks. (3) Prior staffing level experience with other feeding systems and the XM-75 system at Camp Edwards established that the required workload could be accomplished with less cooks with these types of system improvements.

Messmen: In theory, Marine Corps kitchens are authorized 1 messman per 25 consumers and these messmen are drawn from the units being supported. However, based on observations made at Marine Corps field training exercises the number of messmen actually provided is usually between one per forty and one per fifty consumers. It was, therefore, decided to staff the control system with sufficient messmen so that it would be representative of real world Marine Corps operations. Therefore, a total of 20 messmen (1 messman per 45 customers) were assigned to the control system. By comparison, the XM-75 and XM-76 systems were only provided 15 messmen because of efficiencies of the new sanitation center (See Chapter III), and the introduction of disposable mess gear which eliminated the need for setting up, maintaining, and operating mess kit wash lines.

Actual Staffing Levels

The actual staffing levels of the control system were identical to those planned; two supervisors, two bakers, twelve cooks, and twenty messmen. The design staffing levels for the XM-75 and XM-76 systems included two supervisors, eight cooks, two bakers, and fifteen messmen. After operating the XM-75 for a short period, supervisory personnel felt that they were understaffed and the workload was sufficient to justify one more cook and one more

messman. Therefore, the staffing for the XM-75 was increased to nine cooks and sixteen messmen (the bakers were unchanged). During the first day of operation of the XM-76, supervisory personnel requested two additional messmen, bringing the total to 18. Staffing for cooks and bakers was not changed with the XM-76.

Determination of Required Staffing Levels

It is normally expected that the designed staffing levels and the actual staffing levels used during an experiment will vary from the actual number of people required as determined from the work sampling data. The purpose of this section is to describe how the actual staffing requirements for each system were calculated from the analysis of the work sampling data for each system. The average number of productive hours expended to operate each system on a daily basis as derived from the work sampling data provides the basis for determining the required staffing levels.

Ideally, the number of man-hours scheduled to operate a system would equal the number of productive man-hours required to operate the system. However, due to variations in the workload and the fact that some unproductive time is unavoidable and even desirable (to cover breaks, accidents, personal time, etc.), the number of man-hours scheduled has to be larger than the number of productive hours required. In turn, the number of personnel required is a function of the number of scheduled hours and the length of the workday. In general, the number of personnel required to operate a system can be estimated by

$$N = \frac{H_p}{P \times WD}$$

where N = number of workers required on a daily basis.

H_p = number of productive hours expended daily to operate the system (units = productive man-hours/day)

P = portion of each available hour which is productive, for example if P = 0.75 assume each available man-hour yields only 45 man-minutes (0.75 x 60) of productive effort on the average (units = productive man-hours/available man-hour)

WD = length of an employee's workday (unit = available man-hours/individual)

The average number of productive hours expended daily by each worker category and the total workforce while operating each system can be estimated from the work sampling data (Chapter IV). By utilizing the above formula the number of workers actually required by each system in each worker category as well as the size of the total workforce can be estimated. It is important to note, however, that the average number of productive hours of effort expended

TABLE 8. STAFFING REQUIREMENTS

	Control			XM-75			XM-76		
	Prod Man-hrs per day	Avail. Man-hrs Req	No. * Workers Req	Prod Man-hrs per day	Avail. Man-hrs Req	No. * Workers Req	Prod Man-hrs per day	Avail. Man-hrs Req	No. * Workers Req
Supervisors	10.6	14.1	1.2	11.4	15.2	1.3	11.1	14.8	1.3
Cooks/Bakers	123.6	164.8	14.5	99.3	132.4	11.7	86.0	114.7	10.1
Messmen	159.0	212.0	18.7	96.0	128.0	11.3	106.7	142.3	12.6
Total Workforce	293.0	390.6	34.5	206.6	275.5	24.3	203.9	271.9	24.0

*Mathematically, assuming a 25% non-productive rate and a 11-hour workday

Available Man-Hours Required = (Productive Man-Hours per day)/(0.75)
Number Workers Required = (Available Man-Hours Required)/(11-1/3)

daily by the entire workforce is representative of total effort required to make the system operate. However, in some instances, the average number of productive hours of effort expended by a specific category of worker may not be truly representative of the effort required by that worker category to make the system operate. For example, some tasks like preheating insulated food containers, cleaning range cabinets, serving food, etc., can usually be performed by either cooks or messmen since little or no training is required. The type of individual, cook or messmen, who actually performs these tasks is often an arbitrary decision based on who happens to be available. Therefore, in many instances the number of productive hours of effort expended by each worker category during the experiment is largely dependent upon how the supervisors distributed the work.

Calculated Required Staffing Levels

Table 8, which is based upon the work sampling results and the methodology detailed above summarizes the calculated required staffing levels for each system. These calculated staffing levels are based on the following three assumptions: (1) During combat situations the length of the workday is 12 hours; (2) only 11-1/3 hours of each individuals workday is available with the remaining time required for messing purposes; and (3) 25% of each individuals available time is classified as non-productive. Thus each person who works a 12-hour shift provides only 8.5 (11-1/3 x 0.75) productive man-hours of effort.

The assumption of a twelve hour workday with 40 minutes for messing purposes is based upon the Camp Pendleton experiment. Based upon the work sampling data the average length of the workday; to include productive time, non-productive time, and meal breaks, for all personnel while operating each system is summarized in Table 9.

TABLE 9. AVERAGE LENGTH OF WORKDAY

	Hours/Day		
	Control	XM-75	XM-76
Supervisors	12.9	14.1	13.1
Cooks/Bakers	12.9	11.9	11.9
Messmen	12.4	9.3	11.1

Supervisors average between 12 9 and 14.1 hours per day. However, a large portion of this time was classified as non-productive and more effective scheduling to reduce the amount of time both supervisors are on duty could reduce the length of the workday, the amount of time on duty, to 12 hours or less. The cooks averaged 12.9 hours per day while operating the control system and 11.9 hours while operating each experimental system. The messmen showed more variation ranging from 9.3 to 12.4 hours per day. The longer workday for messmen while operating the XM-76 system as compared to the XM-75 system is due to more non-productive time and longer meal breaks. Based upon

these data, a 12-hour workday appears reasonable. The 40 minutes allowed for messing purposes is based upon the work sampling data for cooks which shows that each cook averaged 36 minutes daily for this purpose.

Supervisors: The number of supervisors required by each system is approximately the same, ranging from 1.2 to 1.3 supervisors per system. To provide some depth in the supervision area, the proposed staffing requirements include two supervisors (E6 and above) for each system. This way one supervisor is still available to provide direct supervision over the operation of the field kitchen whenever one supervisor was required to be away from the kitchen for one reason or another. The lower grade supervisor would be considered a working supervisor.

Control System: The number of cooks/bakers and messmen required by the control system was 14.5 and 18.7, respectively. Rounding to the nearest whole number, results in a calculated staffing level of 15 cooks/bakers and 19 messmen for the control system.

XM-75 and XM-76 Systems: The XM-75 required 11.7 cooks/bakers while the XM-76 requires only 10.1. However, the XM-75 requires only 11.3 messmen while the XM-76 requires 12.6. This is because the cooks spent less time on cooking, serving, and filling insulated food containers with the XM-76 system than they did with the XM-75 system while the messmen dedicated more time to these tasks with the XM-76 system than they did with the XM-75 system. Therefore, due to the shift in the workload from cooks to messmen with the XM-76 system it appears that the XM-76 requires fewer cooks, but more messmen than the XM-75. This is due to the fact, as previously mentioned, that some tasks can be and are performed by both food service personnel and messmen, depending upon the number of messmen available. Another aspect of the relative labor requirements of both systems concerns the total number of personnel required. Here both systems are virtually identical with the XM-75 requiring 23.0 cooks/bakers and messmen while the XM-76 required 22.7. Therefore, the calculated staffing requirements for cooks/bakers and for messmen were based on the average number estimated for both systems. Based on the work sampling data the average number of cooks/bakers required to operate each experimental system is 10.9 ((11.7 + 10.1)/2). Rounding to the nearest whole number results in a calculated staffing requirement of 11 cooks for each experimental system. Similarly for messmen, the average number required to operate each experimental system is 11.9 ((11.3 + 12.6)/2). Rounding to the nearest whole number results in a calculated staffing requirement of 12 messmen per experimental system. Also by averaging the proposed staffing requirements for cooks/bakers and messmen are based on eight days of work sampling data and, therefore, should be more reliable than those obtained by estimating each systems staffing requirement individually which would be based on only four days of work sampling data.

Recommended Staffing Requirements

The calculated staffing levels were based on the work sampling data. However, work sampling data were collected at the kitchen site only and, therefore, do not include the number of man-hours expended on the following two

activities; delivering prepared rations to units at remote feeding sites, and obtaining rations. Based on observations made at Camp Pendleton and other Marine Corps exercises, it is estimated that one cook man-day and one messman man-day would be sufficient to cover these two tasks (units usually provide servers at remote feeding sites). Therefore, to insure adequate staffing for each system, one additional cook and messman have been included in the recommended staffing levels. See Table 10.

TABLE 10. RECOMMENDED STAFFING REQUIREMENTS

	No. of Individuals		
	Control	XM-75	XM-76
Supervisors	2	2	2
Cooks/Bakers	16	12	12
Messmen	18(20)*	13	13
Total	36(38)*	27	27

*If control system utilized standard mess gear.

Conclusions

Assuming (1) all kitchen personnel work a 12-hour shift; (2) 11-1/3 hours of each individuals workday is available with the remaining 2/3 hours required for messing purposes; and (3) 25% of each individual's available time is classified as non-productive; then the following conclusions are made based upon the work sampling data:

1. The work sampling data suggests that the control kitchen was understaffed by two cooks.

2. Compared to the authorized staffing of the control system, the XM-75 and XM-76 systems achieved a net savings of two cooks. However, based on the work sampling analysis, the control system was understaffed by two cooks and, therefore, the experimental systems offer a savings of four cooks over the control system.

3. The control system required 20 messmen. However, if disposable mess gear was utilized only 18 messmen would be required, a savings of two messmen.

4. The experimental systems require five fewer messmen than the control system when all systems utilize disposable mess gear.

5. The experimental kitchens require 49% fewer personnel than an Army battalion (strength 875) utilizing company level kitchens. This equates to a savings of 15 cooks and 10 KP's.

CHAPTER VI

FOOD ANALYSIS

The purpose of this chapter is to discuss the menu utilized, food cost, nutrition, class 1 supply system, food preparation times, and food quality.

Menu

A five day breakfast and dinner meal menu (see Appendix C) was developed for the experiment using DoD Food Preference data.[3] The menu was designed primarily to offer only highly preferred foods. Secondary considerations were:

(1) Minimize use of perishables (e.g., canned vegetables rather than frozen).

(2) Utilize foods that would not require excessive preparation labor.

(3) Utilize foods which were compatible with the field kitchen equipment provided.

(4) Utilize foods that maintain quality when transported in insulated food containers for serving in remote areas.

To approximate actual field conditions, the meal discipline was hot morning and evening meals with the Meal, Combat, Individual (M-C-I) for the noon meal.

In addition, a three day menu using B-ration items was developed for the final three days of the experiment. As much as practical, the menu items selected were high preference and comparable to those on the five day A-ration menu. The only deviation from a pure B-ration discipline was a change to fresh milk due to consumer resistance to non-fat dry milk. The impact of this on the experiment was considered negligible. Fresh bread was supplied by a vendor under the assumption that a field bakery would be available.

Cost

The new menus were analyzed for cost and nutrition using computer programs designed for that purpose. Costs are based upon Defense Personnel Support Center (DPSC) price information as of 1 April 1976 and allow comparison with the March 1976 Basic Daily Food Allowance (BDFA) obtained from Camp Pendleton. It should be noted that the cost of the new A-ration menu was expected to exceed the BDFA. The

[3] Meiselman, H.L., et al., "Armed Forces Food Preferences", Technical Report TR 75-63-FSL, US Army Natick Development Center, December 1974.

requirement of repeating the menu for three consecutive weeks necessitated the use of only the most highly preferred foods (usually high cost) and prevented the use of lower cost (off-setting) foods. The high, low, and average costs for the five day A-ration and three day B-ration are shown in Table 11. When the effects of the high cost steak meals and the relatively high cost M-C-I noon meals were eliminated from the A-ration cost by substituting the average cost of the remaining evening meals ($0.98), the ration cost of $2,57 per day was less than the Camp Pendleton BDFA of $2.61 by 4 cents. The actual food cost was $3.21 somewhat lower than our calculated cost of $3.24. In the case of the B-ration only the cost of the M-C-I noon meal needs adjustment. Using the average of the 3 evening meals ($1.03) for the noon meal,the average daily cost was $2,68. Thus the cost of the B-ration menu was slightly higher than the comparable BDFA. Tables 1 and 2 of Appendix C present the detailed cost data.

TABLE 11. MEAL COSTS*

	Meal	Low	High	Average
A-Ration	Breakfast	$0.51	$0.70	$0.61
	Noon	1.46	1.46	1.46
	Evening	0.78	1.91(1.29)	1.16(0.98)
	Total	2.89(2.41)	3.91(2.79)	3.24(2.57)
B-Ration	Breakfast	0.47	0.68	0.61
	Noon	1.46	1.46	1.46
	Evening	0.69	1.22	1.03
	Total	2.83(2.40)	3.33(2.90)	3.11(2.68)

*Figures in parentheses are adjusted to eliminate the high cost steak meal and high cost M-C-I noon meals by substituting the average of the other evening meals ($0.98 for A-Ration; 1.03 for B-Ration).

Nutrition

Figures 1 through 4 in Appendix C present a nutritional analysis of both the A and B-ration menus. The nutrients shown are those for which the Military prescribes a Daily Dietary Allowance[4] (DDA). Nutritional values were calculated for each food item using the Armed Forces recipe service formulations for 100 servings and Agriculture Handbook No. 8[5] nutrient contents, except for cooked

[4]AR40-25, "Medical Services Nutritional Standard", Dept. of the Army, 10 August 1972.

[5]Composition of Foods", US Dept. of Agriculture, Agriculture Handbook No. 8, Agricultural Research Service, USDA, Washington, DC, December 1963.

meats where the Armed Forces Handbook[6] was used for nutrient contents. The nutritional values were then summed over all food items comprising each meal. The average nutrient values for the menus, DDA for male personnel, and the average nutrient value expressed as a percent of this DDA have been extracted from Figures 1 and 2 of Appendix C and summarized in Table 12. On a daily basis, both menus are nutritionally adequate, usually by a wide margin. Even fat, excess dietary amounts of which have caused some controversy in the last few years, is in line with its requirement.

TABLE 12. AVERAGE NUTRIENT VALUE OF CAMP PENDLETON MENUS

		A-Ration		B-Ration	
Nutrient (Units)	Military DDA	Ave. Value	% of DDA	Ave. Value	% of DDA
Calories	3400	4453	131	4245	125
Protein (g)	100	177	177	157	157
Fat (g)	Max*	198	103	184	98
Calcium (mg)	800	1396	175	1518	190
Iron	14	28	199	24	168
Vit. A (IU)	5000	9401	188	7935	159
Thiamine (mg)	1.7	5.3	314	5.3	312
Riboflavin (mg)	2.0	3.7	183	3.6	182
Niacin (mg)	22	37	167	30	137
Ascorbic Acid (mg)	60	180	300	136	227

*Calories from fat should be less than 40% of the menu calories. Using 9 calories per gram of fat, the A-ration menu should contain less than 198 grams of fat and the B-ration menu less than 188 grams of fat.

Figures 3 and 4 of Appendix C show the values for breakfasts, lunches, and dinners for the A-ration and B-ration menus, respectively. For analysis on a per meal basis, it was assumed that each meal should provide one-third of the DDA. This is approximate at best since all three meals are not equal. Only niacin in breakfasts could be considered borderline. However, if niacin equivalents from tryptophan are considered, this potential shortfall is eliminated. According to Agriculture Handbook No. 8, tryptophan from eggs can contribute 1.6 mg of niacin equivalents per day, and eggs are a major component of each breakfast.

It must be emphasized that the nutritional values presented are computer estimates of average nutrition available, not nutrients consumed. Calculations assume standard portion sizes and some of each menu item. No allowance has been made for food losses during preparation or for food left at the end of the meal.

[6]DSAH 1338.1, "Composition of Foods Used by the Armed Forces," Defense Supply Agency, May 1964.

Another source of loss, plate waste was probably minimal, since the menu offered only one of each menu component (no choices) and the Marines being fed were active, they tended to take and eat whatever was offered. Also, there is no allowance for nutrient losses resulting from heating vegetables, cooking pastries, holding the food hot on the serving line, or while transporting the hot food in insulated food containers. However, daily thiamine is over 300% of DDA and daily ascorbic acid is over 200% of DDA providing considerable excess of the most heat liable nutrients.

Class I Supply System

One of the Camp Pendleton dining halls was designated as the ration breakdown point. Food items, with an exception of milk, required for a given day were delivered to the kitchen during the afternoon of the preceeding day. Milk, which is bulky, was delivered two times a day. Frozen food was tempered at the dining hall and issued so that it would be in a state where it could be handled, but would not be completely thawed at the start of meal preparation.

Food Preparation Times

Detailed preparation procedures were observed for selected food items. This allows comparison of preparation times between the control and experimental kitchens using specific foods. Table 13 extracts the preparation time data from the more detailed observations shown in Table 3 of Appendix C.

TABLE 13. FOOD PREPARATION TIMES

Food Item	Quantity for 900 Portions	Control	XM-75/XM-76
Dinner Items:			
Vegetables	36 - #10 Cans	3 Man-hours	3 Man-hours
Mashed Potatoes	9 - #10 Cans	3-1/2	3-1/2
Baked Potatoes	120#	3-3/4	3-3/4
Salad (Lettuce & Tomato)	3 Cs Let. 3 Cs Tom.	6-1/2	4-1/2
Brownies	-	5	5
Stuffing	-	6	6
Pork Chops	288#	8	3
Roast Turkey	360#	12	8-1/2

TABLE 13. FOOD PREPARATION TIMES (cont'd)

Food Item	Quantity for 900 Portions	Control	XM-75/XM-76
Breakfast Items:			
Scrambled Eggs	6 Cs	6	2
Sausage	135#	4	2
Hash Brown Potatoes	40#(dehy)	3-1/2	2
Creamed Beef	90# beef	4	4
Bacon	140#	6	-
Biscuits	-	6	6

Using main meal items (veg., pot., salad, meat, and dessert) pork chops, roast beef and roast turkey dinners required 26, 31 and 36 preparation man-hours in the control kitchen and 19, 24-1/2, 30 preparation hours for the corresponding meals in the XM-75 and XM-76 kitchens. For a typical breakfast the preparation times were 23-1/2 versus 16 hours, respectively. Thus, the griddles of the experimental systems reduced preparation time by 30% with grilled meals, whereas the meat slicer and salad cutters reduced preparation time by 15-20% with roast meals.

Food Quality

In addition to the consumer surveys (see Chapter VII), food quality was also assessed by food technologists located at the kitchen site. Their observations are provided in this section. Food preparation procedures and practices were generally satisfactory. One problem was consistantly noticeable, i.e., the tendency to prepare food too far in advance. Part of the reason for this tendency is that the food needed for serving at remote sites had to be ready as much as two hours before meal time - a condition common to field feeding.

Recipes were used to a greater extent than previously observed in many food service operations. Recipes were extracted from the Armed Forces recipe file cards onto forms that were posted with the cook's worksheet. Cooks usually read the recipe before starting preparation of a food item. However, the limited table space and crude conditions that are integral to field kitchens make referring to a piece of paper (recipe) during food preparation inconvenient. In addition, as the experiment progressed, recipes were less and less evident since the menu was repeated three times.

Food quality was generally good. However, technical observations indicated that several menu items presented problems when used in a field menu. When barbequed chicken was served, for example, the customers thought they were getting only bones. Chicken held in sauce overcooked to the extent the meat fell of the bones. Another problem concerns roast beef and roast turkey which reached unsafe temperatures of 100^{0}-130^{0}F when tempered (cooled) for slicing.

Conversely, if they were sliced hot, the meat fragmented into bits and pieces. Thus, roast meats must be re-heated after slicing either with hot gravy or by further cooking.

As with the previous field experiment at Camp Edwards[7], bakery items exhibited the most quality variations. This is attributed to oven temperatures which are difficult to control in the M-59 range cabinet.

[7] op. cit. 2

CHAPTER VII

CONSUMER ACCEPTANCE

One of the main objectives of the experiment was to determine if consumers perceive any significant differences in meal acceptability among the three systems being evaluated. Therefore, a concerted effort was made to obtain consumer acceptance data throughout the experiment. This was especially important since the two experimental systems operated during the experiment had significantly reduced staffing levels and improved kitchen equipment. It was desired to determine if the improved efficiency of the two new systems was achieved at the expense of food quality.

The consumer data obtained was a result of interviews and questionnaires administered by Behavioral Scientists from NARADCOM. It should be noted that food acceptance ratings of each food item in a meal were obtained from consumers by asking them to fill out a food rating survey (See Appendix D). These sheets allowed consumers to rate overall meal quality and individual meal components on a 9-point hedonic scale. They also allowed customers to rate serving temperatures on a 5-point scale (See Appendix D) and asked the consumers by interview if they got enough to eat. Data were obtained for virtually every meal from both the consumers at the remote sites as well as those who ate at the kitchen site.

Meal Acceptance

Acceptance ratings obtained included the A-ration and B-ration, as well as a limited number of M-C-I's. These ratings represent the consumers concensus of the meal based on the combinations of foods which were served on a particular day.

Acceptability of A-Ration Meals: The overall meal ratings, which are shown in Table 14, indicate that for the A-ration, there were only very slight differences among each of the three systems and meals from all three systems received exceptionally high ratings indicating a high degree of consumer satisfaction. It should be pointed out that only data from those consumers who were located at the remote sites were included in Table 14. This is due to the fact that this is the worst case and also more nearly represents the situation as it would exist in actual combat.

TABLE 14. OVERALL MEAL ACCEPTANCE RATING FROM REMOTE SITE CONSUMERS*

	Type of Ration		
System	A	B	M-C-I
Control	7.2	-	-
XM-75	7.1	-	-
XM-76	7.5	5.1	-
M-C-I	-	-	3.9

*Based on a 9-point Hedonic Scale.

Of particular interest is the fact that virtually all of the breakfast meals were rated lower overall than the dinner meals with only three exceptions (See Tables 1 and 2 of Appendix D). Some of the lower ratings received for breakfast can be explained by the fact that on a few days the food service personnel had difficulty in locating some units; thus, meals were served late at the remote sites. Also, in several instances, more consumers were available than had been forecast and extreme portion control had to be exercised in order to assure everyone received a meal.

Acceptability of "B"-Ration Meals - The data shown in Table 3 of Appendix D for the B-ration represents a very significant reduction in consumer acceptance. Of particular importance is the extremely low ratings for the breakfast meal which averaged over one hedonic point below the dinner meal. Scrambled eggs at breakfast proved to be the most troublesome item on the entire B-ration menu which is not surprising since the dehydrated egg mix component had a 6-73 expiration date.

Acceptability of M-C-I Meals - M-C-I's provided for the noon meal were not well received by consumers (See Table 4 of Appendix D). Their overall rating during the experiment was 3.9. This is well below the neutral point of 5.0 and indicates the consumers disliked the M-C-I's. These limited data confirmed earlier reports[8] of poor acceptability of some M-C-I components. One major exception which is noteworthy, was the fruit component which has been consistently popular especially in warm, dry climates.

Acceptance of Meal Components

The food acceptance ratings for the specific meal components, including both onsite and remote area consumers, are also provided in Tables 1-4 of Appendix D. The acceptance ratings collected from consumers for the A-ration menu resulted in only four ratings below the neutral point of 5.

Serving Temperature

In addition to food acceptance data, serving temperature data were also collected. The serving temperature was rated on a 5-point scale: foods which were just right in temperature were rated 3, while foods which were too warm received higher ratings (either 4 or 5) and foods which were too cold received lower ratings (either 1 or 2). Ratings from both onsite and remote consumers, (Tables 3-6 of Appendix D) showed there were very few serious serving temperature problems since most hot foods averaged between 2.7 and 3.0, and most cold foods

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[8] Meiselman, H.L., et. al., "Field Feeding: Behavioral Sciences Studies", Technical Report 76-3-FSL, US Army Natick Development Center, Natick, MA 01760, January 1975.

averaged 3.0 to 3.3. The fact that consumers were quite satisfied with the serving temperature of the food served at remote sites, which is often a serious problem, is in agreement with observations made at the kitchen site during the experiment; namely, the prescribed steps for preheating the insulated containers were rigorously followed throughout the experiment.

Food Quantity

An interview consisting of two questions which required yes or no answers was used to assess consumer attitudes toward the quantity of food they were receiving. It is important to note that the interview referred to the quantity of food received on the previous day and thus was not affected by the specific context in which the interview was given. As was the case in previous studies, a significant number of the respondents (up to 53%) indicated that they did not receive enough to eat on the day before the interview (Table 7 of Appendix D). It is interesting to note that during the second week of the experiment, the frequency of negative responses decreased substantially which is the result of the feedback from the first week's questionnaires being acted upon by supervisory personnel by increasing portion size.

When asked, "do you eat more in the field", most consumers responded that they did not. However, on specific days more than half of the respondents did report eating more. One possible explanation is that people begin to eat more in the field as the duration increases.

Conclusions

As a result of the foregoing analysis, the following can be concluded:

1. A-ration meals served to the consumers from all three systems being evaluated during the experiment were highly acceptable with no particular system offering a clear advantage in terms of meal acceptance.

2. Consumer ratings of B-ration meals and MCI's were significantly lower than were the meal ratings for the A-ration. The breakfast meal for the B-ration presented a more serious problem than did the dinner meal particularly in regard to the scrambled egg component. The only positive rating received on the MCI was for the fruit component.

3. Consumers located at the remote sites complained more frequently than consumers eating onsite in regard to not receiving sufficient quantities of food. In general, the number of consumers complaining of insufficient quantities decreased substantially as the experiment progressed. This was a direct result of adjustments in meal component portion size.

CHAPTER VIII

SANITATION

The Food Microbiology Group of the Food Sciences Laboratory determined the ability of the three food service systems to maintain acceptable standards of cleanliness and sanitation. This consisted of monitoring the portable water supply, food contact surfaces, wash lines, pots-pans-utensils and mess kits by temperature profiles, microbiological analyses and visually. The microbiological procedures followed are detailed in Appendix E.

Pot and Pan Washing

Control System: The washing and sanitizing of pots, pans, and cooking utensils were monitored daily. The control system basically consisted of two wash lines each having three GI cans: wash, rinse and iodine disinfectant rinse. Four additional GI cans with immersion heaters provided the hot water. It should be noted that the operation of these lines was varied depending upon workload and number of messmen available, sometimes having one wash and one sanitizing rinse or three wash and two sanitizing rinses.

The effectiveness of the standard Marine Corps system for washing pots and pans was extremely difficult to control. The APC was often very high (see Table 15 and Table E-1) and was accompanied during one testing period by coliform organism and Escherichia coli. The difficulty with the use of iodine was the rapid depletion of its effectiveness when food materials were allowed to accumulate in the rinse water. A further decrease in effectiveness was due to low rinse water temperatures. Prolonged operations with this sanitation equipment would be expected to present a serious health hazard since there is no practical way for the messmen to either determine when the iodine disinfectant has been depleted or in maintaining rinse water within an acceptable temperature range.

TABLE 15. MONITORING OF POT AND PAN OPERATION

	Wash	Rinse	Final Rinse	Final Rinse APC (Organism/ml)	Final Rinse Coliform (Organism/ml)
Control	124	126	111	4-TNTC[a]	0-TNTC
XM-75/XM-76	136	153	159	2-284	0-16

[a]Too numerous to count, exceeds 300

XM-75/XM-76: The new sanitation system depended on hot water exceeding 170°F for the sanitizing rinse. It consisted of four sinks: two wash, one rinse, and one sanitizing rinse. Hot water for four sinks was provided by a standard laundry and shower unit water heater. A M-2 burner placed under each sink maintained the water hot.

Initial difficulty was encountered with the new sanitation system. On four days, organisms were detected in the final rinse water, generally in low numbers. On three occasions, coliform were also present, and the presence of E. coli was verified on two of these days. These difficulties were due to low sanitizing rinse water temperatures and were rectified as personnel became more accustomed to adjusting the burner units under the new field sinks. During the third week temperatures improved considerably.

One final point should be made concerning water temperature. In the absence of monitors, the new field sinks should be equipped with a thermometer, since the temperature of the water in the final rinse was found to be below 170°F (77°C) on a number of occasions. The availability of a thermometer should make it much easier for operating personnel to keep the rinse water above 170°F.

Potable Water

Two water trailers were used for storing and distributing potable water. These trailers were sanitized before use by a flush, chlorine rinse and an additional flush. They were tested daily for their APC, coliform, available chlorine, and pH. As shown in Table E-2, the pH ranged from 6 to 7 and the available chlorine from 0 to 1.5 ppm. In no instance was the APC greater than 100 and no coliform organisms were detected.

General Sanitation

The sanitary quality of the equipment and utensils in the XM-75 and XM-76 systems represented a drastic improvement over the control system. Specifically, as shown in Table 16, the overall improvement in the XM-75 and XM-76 systems as measured by Rodac plates was about 30%. However, as shown in Table E-3, the sanitary level attained for a number of items was even more dramatically improved. These items include pan covers and large pots and pans. One problem common to all three systems concerned stainless steel table surfaces, dippers and cutting boards. These items consistently had high counts.

TABLE 16. EVALUATION OF EQUIPMENT SURFACES BY RODAC PLATES

System	Surfaces Tested	Percentage Satisfactory
Control	99	38
XM-75	177	54
XM-76	97	58

Evaluation of utensils by the swab technique (see Table E-4) also indicated a general overall improvement in the XM-75 and XM-76 systems. Dippers, forks, ladles, serving spoons and tongs showed a 35% improvement, although in isolated instances the counts still remained at a high level.

Mess Kits and Eating Utensils

The mess kit meat pan was evaluated by Rodac plates and the mess kit knife, spoon and fork by the swab technique. Three approaches in evaluation of the mess kit bodies were taken.

First, the same mess kit bodies were evaluated prior to and after the hot water predip; second, some were randomly selected for evaluation before and again after dipping; and third, others were randomly selected from the holding containers for evaluation. Regardless of the method used in evaluation it was obvious that a hot water dip was essential. As shown in Table 17, prior to the dip 40-53% of the pans were satisfactory whereas 83-93% were satisfactory after the dip. Some (4/50) were found to still have high microbial populations even after the hot water dip. Table E-5 presents the detailed results.

TABLE 17. EVALUATION OF MESS KIT MEAT PANS BY RODAC PLATES

	No. Tested	% Satisfactory (Water $\geq 170^{0}F$)	
		Before Dip	After Dip
Holding Box	140	53	-
Matched (Same Body)	15	53	93
Random	25/35	40	83

As summarized in Table 18 and detailed in Table E-6, the mess kit utensils were often found to have high microbial counts. These items were tested prior to a sanitary dip. Approximately 55% of the utensils contained less than 200 CFU/utensil, 71% less than 500 CFU/utensil and 15% contained over 1500 CFU/utensil, indicating that an effective sanitary treatment prior to use is essential. Spoons had the highest incidence of microbial populations of over 100 or 500 CFU/utensils.

TABLE 18. MICROBIOLOGICAL EVALUATION OF MESS KIT EATING UTENSILS

	Number Tested	Swab Count (Organism/Swab)		
		0-200	201-500	>500
Knife	20	10	6	4
Fork	23	17	0	6
Spoon	19	7	4	8

Conclusions

1. The new sanitation equipment provided with the XM-75 and XM-76 systems represented a significant improvement over the control system and greatly reduced the potential for food borne illness. However, a thermometer should be provided with the new field sinks.

2. While the overall sanitation of the XM-75 and XM-76 systems represented a significant improvement over the control system, certain items of equipment still presented specific problems. In particular, the preparation and serving tables, cutting boards and dippers of the old and new systems and the vegetables and meat slicers of the new systems were frequently unsatisfactory and require improved cleaning methods.

3. A hot water predip ($170^{o}F/77^{o}C$) is necessary for sanitizing mess kits and their utensils. Without the predip a large proportion of the kits and utensils were unsatisfactory, and even after the predip some mess kits were still found to be unsatisfactory.

CHAPTER IX

FOOD SERVICE WORKER ACCEPTANCE

The behaviorally oriented assessment of the three field kitchens consisted of determining the food service worker acceptance by means of a series of interviews and surveys. The following were administered to the food service supervisors, cooks, and messmen by NARADCOM Behavioral Scientists:

Food Service Worker Interview (Weekly)
Food Service Worker Attitude Survey (Weekly)
Food Service Worker Final Interview
Food Containerization Interview (Weekly)
Sanitation Center Interview (Twice)
Messman Interview

Demographics

The food service workers interviewed and surveyed included three permanent messmen, one PFC, two CPL's, four LCPL's, one SGT, one SSGT, and one MSGT. Their food service experience in the field ranged from a few weeks to three years. Two of the cooks had only on-the-job training, while the other eight had been through the basic cook's course. The NCOIC and his assistant had attended several of the higher level schools at Camp Lejeune. Their attitudes toward the military and food service in general were quite positive with 80% stating that they liked the military either moderately or very much; and 90% indicating that they would not like to transfer to duties other than food service. The only cook who wished to transfer professed to dislike the military very much.

Overall Comparison: The food service workers were surveyed and interviewed on Thursday of each week concerning the kitchen used that particular week. In addition, they were given a final interview near the end of the experiment in which they were asked to compare all three systems. A seven point Likert Scale ranging from Very Bad = 1 thru Neither Bad nor Good = 4 to Very Good = 7 was used to obtain their ratings of various attributes and of the overall systems.

Both the final interview and the weekly surveys clearly demonstrated the workers' preferences for the XM-75 Kitchen System. Of the nine cooks interviewed for all three systems, all preferred the XM-75. A comparison of the mean overall ratings calculated from the Likert Scale values (Table 19) adds testimony to the strength of this preference with the mean rating for the XM-75 being 1.7 points higher than that for the control and 2.5 points higher than that for the XM-76. Furthermore, every worker gave the XM-75 an overall rating of either good or very good, while only 30% and 20% rated the control and the XM-76 kitchens, respectively, at these scale points.

TABLE 19. OVERALL COOK RATINGS OF THE THREE FIELD KITCHENS

	Very Bad(1)	Bad(2)	Slightly Bad(3)	Neither Good nor Bad(4)	Slightly Good(5)	Good(6)	Very Good(7)	Mean Likert Rating
Control	0	0	20%	10%	40%	30%	0	4.80
XM-75	0	0	0	0	0	50%	50%	6.50
XM-76	0	20%	20%	20%	20%	20%	0	4.00

Table 20 displays the mean ratings of the attributes contained in the surveys for the three kitchen systems, arranged from top to bottom in order of decreasing differences between the XM-75 and the control. The XM-75 has the highest rating on all 19 attributes. The workers see it as particularly advantageous (at least 2 points higher on the Likert Scale than the next kitchen) in the areas of temperature, smoke and steam, safety, getting rid of waste water, and amount of storage space.

TABLE 20. FOOD SERVICE WORKER SURVEY

Attributes	Mean Rating* Control	XM-75	XM-76
Temperature	2.2	6.3	3.1
Amount of Fumes and Steam	3.6	6.7	3.6
Safety	3.6	6.2	3.3
Getting Rid of Waste Water	3.3	5.4	3.4
Storage Space	4.0	6.0	3.9
Ease of Serving (Kitchen)	4.6	6.5	4.7
Bumping into Other Cooks	3.5	5.3	2.1
Kitchen Size	4.5	6.1	2.5
Sanitation	4.2	5.8	4.1
Lighting	4.6	6.1	4.0
Noise Level	4.4	5.8	3.9
Insect Control	4.3	5.6	4.0
Ease of Cleaning	5.4	6.5	4.8
Accessibility of Kitchen Supplies	4.9	5.8	3.5
Ease of the Menu	5.5	6.2	4.6
Ease of Preparing a Meal	5.5	6.2	3.9
Length of Customer Wait in Line	5.7	6.3	5.3
Ease of Moving Kitchens	5.0	5.4	4.5
Location for Packaging for Field Delivery	3.6	4.0	3.1

*Seven-point Likert Scale: 1 (Very Bad) - 4 (Neither Bad nor Good) - 7 (Very Good)

Control Systems: The weekly interview at the end of the first week concerned the control system. There was a long list of reported dislikes, including the heat in the kitchen (90% of the workers responding), lack of working space (60%), and insufficient storage space for pots and pans (20%). Questions about the serving line prompted several negative comments. Among others, workers maintained that there was too little space for both workers and customers around the serving line (50%), that the improvised serving line which consisted of wooden mount out boxes was unsanitary (30%), that something was needed to keep the food warm (30%), and that the whole serving line was simply too "make-shift" (30%). When asked about other needs for the kitchen, three workers (30%) mentioned the need for grilles other than the squarehead pan and cover.

XM-75 System: The weekly interview responses concerning what the workers liked about the XM-75 included temperature (60%), the amount of space (50%), the serving line (40%), and the separation of the cooking and serving area (30%). A question in the weekly interviews concerning what was disliked about the XM-75 or what could be added to it, led to a few cooks expressing a desire for a deep fat fryer (30%), a place to hand utensils (20%), and one more eight food length of tent for the extension of the serving line (20%). The final survey showed similar results, with the most liked features being the amount of space (78%), the steam tables (44%), the separation of the cooking and serving areas (33%) and the temperature (33%).

XM-76 System: The weekly interview responses concerning what the workers liked about the XM-76 included the efficiency of the griddle (50%), the feeling that a single trailer could be detached to support a smaller unit (20%) and the usefulness of the storage cabinets and drawers (20%). The most frequent negative comments included the temperature in the kitchen (50%), inadequate working space (40%), that the ranges were too high off the floor (30%), that the trailers weren't level (30%), that there were not enough ranges (30%), and that the washing of the trailer floors led to the accumulation of food waste on the ground under the trailers producing a sanitation problem (30%).

Sanitation Center Acceptance

The three messmen who used both the new XM-75 pot washing facility and the traditional arrangement provided for the control system were asked to compare the two. Although not particularly negative about the traditional arrangement, all three preferred the new facility. The major advantages reported were the sinks themselves (height, size, ease of filling, and ease of draining), the temperature and safety in the shelter, and the wire racks provided for storage of utensils.

Specific Items of Kitchen Equipment

Throughout all of the interviews, comments were made by the cooks about individual pieces of equipment. The two items most frequently mentioned were the griddle and the steam tables in the XM-75. The most positive responses

concerning the griddle dealt with the ease of use (70%), the ease of cleaning (60%), and the temperature control provided by the exhaust stacks (30%). The steam tables were praised by workers for their capacity to keep food warm (80%). Half the cooks suggested the modification of the steam table so that standard inserts could be used rather than the squarehead pan.

In response to questions asking if any piece(s) of equipment had made the work easier or the food better, 90% of the workers mentioned the electric meat slicer, 80% mentioned the vegetable cutter, 40% the electric can opener, and 20% the tomato slicer.

Filling Insulated Food Containers

One interview was designed to assess the worker opinions of filling insulated food containers for remote site feeding which comprises a major function of a field kitchen. All three kitchens rated relatively low in providing a means to accomplish this function. This result was not surprising since none of the kitchens included special equipment to accomplish this task.

Conclusions

1. The control system was considered by food service workers to have a large number of serious problems which ranged from too high a working temperature to insufficient storage space.

2. The XM-75 system was much preferred by food service workers by comparison with either the control or XM-76 system.

3. The XM-76 had several items of equipment liked by the food service workers, especially the griddles. The most serious problems expressed by the workers concerned high temperatures and inadequate working space.

4. A new method and equipment are required to improve the efficiency of filling the insulated food containers.

CHAPTER X

HUMAN ENGINEERING

A human factors evaluation of all three kitchens and the pot washing facilities was conducted by NARADCOM behavioral scientists during the experiment. The nature of a human engineering analysis leads to most comments being centered on potential improvements for a system. For this reason, the relatively large number of "negative" comments in this section do not lead to the conclusion that any of the systems are a failure from the human engineering point of view, but only serve to offer suggestions for further improvement. The most critical problem in many kitchens is the excessively high temperature at the worker level. MIL-STD-1472B defines an empirical thermal index based on dry and wet bulb temperatures, and air movement, in terms of the subjective feeling of warmth as effective temperature (ET) and specifies a maximum ET of 85°F for prolonged exposure. Temperature measurements were taken using a battery powered thermistor psychrometer at both waist and face level at several locations within the kitchen shelters. It should be pointed out, however, that the ambients during this exercise were not high enough to severely test the ventilation characteristics of the three systems.

Control

Kitchen Tent: Environmentally, both lighting and noise levels fell within acceptable ranges. However, in this system temperature is an immediately obvious human factors related problem for the workers. Even with relatively low ambients of 50-60°F (ET), cloudiness, and rain; temperatures inside the kitchen tent reached as high as 110°F (ET). On one occasion with an ambient temperature of 79°F, the temperature inside the kitchen tent reached 140°F. At temperature levels like these worker performance not only deteriorates, but the worker's health is threatened with prolonged exposure. In addition, the higher temperatures appeared to lead to more frequent instances of burners becoming overpressurized.

The available workspace in the G.P. Medium Tent is inadequate. Workers were observed to interfere with one an other on numerous occasions. There were also many instances of workers bumping into equipment which often resulted in burns. Containerization of food for the field was accomplished inside the tent further cramping workspace.

Serving Tent: The serving line set up provided additional human factors problems. First, carrying the food from the cooking tent to a serving tent added unnecessarily to the workload. The serving line itself was make-shift in nature with insulated food containers being placed on top of field range mount-out boxes. This arrangement was superior to serving from containers on the ground, but its make-shift nature introduced additional safety hazards of inadvertant tipping or spilling. In addition, the particular set up used in this exercise resulted in the workers being required to serve from too great a working height for maximal efficiency. The wooden surfaces themselves were difficult to clean leading to potential sanitation problems with prolonged use. There was little room for workers to move comfortably behind the serving line and the crowded conditions extended to the customer's side of the line.

Sanitation Tent: The pot washing facility used in the control system introduced some work efficiency problems for the food service workers. The process of carrying water from the water trailer to fill the 32-gallon GI cans being used to heat the water was extremely laborious. It's time consuming and physical strength demanding nature would tend to discourage workers from changing the water as often as would be desirable. Split 55-gallon drums, while a considerable improvement over the 32-gallon can, still would not allow total submersion and thorough cleaning of the larger pots. In addition, the tent itself presents the potential for severe heat stress under higher ambient temperature conditions.

XM-75 System

Environmentally, this kitchen was the most acceptable of the three. Both lighting and noise levels fell within acceptable ranges. For outside ambient temperatures of between 56^{0} and 67.5^{0} (ET), temperatures in the kitchen ranged from 64^{0} to 79^{0}F (ET). Even temperature readings taken at an approximate height of eight feet near the center of the tent did not exceed 85^{0}F (ET). The vents and screening in this tent were apparently serving their purpose.

The amount of workspace provided by the XM-75 was adequate allowing workers to move around without bumping into equipment or each other. In this system, containerizing of the food for the field was also accomplished inside the tent, but without seriously interfering with other kitchen operations. The workspace layout with ranges and work tables at one end of the tent and the serving line at the other facilitated dual operations, i.e., serving one meal and initiating preparation of another simultaneously.

Steam Tables and Griddles: The steam tables constituted a very useful addition to the serving line in maintaining food temperature, particularly with the addition of the hinged squarehead cover. The relative ease of closing and opening this cover encourages the worker to do so when there is a lag in customer flow. These covers might be made even easier to use by the addition of some sort of tab with which to lift the cover and a small slot to allow closing without removal of the serving utensil. The griddles were also an important addition to the serving line, speeding up grilling considerably. However, the grease shoot was too small. The heat shields and exhaust stacks on the griddle and steam table holding racks were effective in keeping groin level temperatures at reasonable levels of between 67^{0} and 102^{0}F. Two lesser problems were created in that the stack bases and the hinges on the heat shields were difficult to clean, and some workers burned themselves on the stack when removing or inserting the squarehead pan. The height of the griddle surface was the ideal 36 inches, but the height of the squarehead pan when inserted in the steam table was 39.5 inches, exceeding the MIL-STD-1472 B limit of 36 ± 0.5.

Serving Line: The entire serving line was lightweight and easy to assemble and take apart. When M-2 burners were in position under the griddle or steam tables, the safety gauges were more easily viewed than in the lower cooking position in

the M-1959 range, but workers still had to stand back or bend to see them partly because they were obscured by the hinged part of the heat shield. If the gauge were moved forward two inches, angled upward, and a viewing hole cut in the shield, it would help alleviate this problem. A thin round rail on the customer side of the serving line, similar to that in the MKT, could serve to protect the customer from the danger of burns as well as providing a surface on which to rest his tray. If this would consume too much extra space, readily viewable red warning lettering should be displayed on the serving line.

Sanitation Shelter: The new pot washing facility used with both the XM-75 and XM-76 systems had very few human factors design flaws. The vented tent kept heat levels below the critical 85°F (ET). Sinks were of the correct height and were large enough to submerge the largest pots and still allow the workers access for their hand in washing. Drying racks were easy to reach and a vast improvement over the present system. The duck boards helped prevent slipping, but had the problem of sections coming apart because traffic caused the fasteners to loosen.

XM-76 System

Temperature: Environmentally this kitchen was intermediate between the other two. Lighting and noise provided no problems. Temperatures, while not as hot as in the control kitchen, were hotter than in the XM-75. With ambient temperatures ranging from 61° to 69°F (ET), temperatures taken in the trailers at waist and head level ranged from 63°to 99°F (ET). Of ten temperature measuring periods over four different days, only two exceeded the maximum safe temperature of 85°F (ET). Once temperatures were 85.5°, 92°, and 99°F (ET) at three different positions (69°F ambient); and once a temperature of 86.5°F (ET) at face level was recorded at one of the cooking positions (68°F ambient). Some of the dry bulb temperatures produced at groin level one foot from the griddle were high for worker safety (137.5°, 115° and 105°F being recorded on three different occasions.) The addition of a heat shield and exhaust stacks as in the XM-75 should be considered. The trailers were used with the canvas flaps down because the cooks feared dust blowing into the food. The effect of raising those flaps on the working environment, however, is a function of where the cook is working and the wind direction. In the one instance when the workers raised the flaps on the trailer, the waist level temperature in the cooking position increased from 76°F to 81.5°F (ET) because the wind was blowing more heat from the ranges and griddle toward the cook.

Kitchen Space Workspace layout in the trailers was the major problem. While the overall area provided by the three trailers was generous, the fixed positions of the equipment in each trailer created a necessity for indirect routes from one location to another, thereby decreasing work efficiency. These same fixed positions also made it difficult for the cooks to pass each other between the equipment, particularly when some were serving and others were attempting to move new pans of food into the line. Probably the most serious safety hazard was installing and removing burner units. This must be done from the cook's side of the line and the person(s) removing a burner must stand sideways because of the lack of space. Burner units should be removable from either side of the line.

The cooking/serving areas had only one open escape route for the cooks in case of emergency, out the open end oriented toward the central platform. With a range door lowered this route was blocked. The cooks had blocked the other escape route, out over the edge of the trailer, by placing a bakery rack or storage cabinets in that space in each of the trailers. Even without the rack or cabinet there, this route is directly over the trailer tongue - certainly better than remaining in a fire, but not ideal in terms of a safe escape route.

The serving line was well structured for both the customer and worker in terms of actually serving the meal. The safety rail both helped protect the customer from burning himself and provided a resting place for his tray.

There were also some work flow (and customer flow) problems caused by the U-shaped serving line patterns in two of the trailers. While this provided the advantage of leaving the third trailer free for additional preparation away from the serving lines, it created the necessity of interrupting the line at the open end of the serving area to allow cooks (often carrying pans of hot food) access. In addition, it was arranged so that the customers leaving the trailer had to cross through the waiting line of customers to reach the eating tents. Both problems would have been eliminated by using two L-shaped serving patterns, each using part of two trailers and exiting from the same trailer, although this would eliminate the separate preparation area.

Equipment: Most of the heights for equipment in the trailer serving line were ideal, the major exceptions being the M-1959 range and squarehead pans. The lower positions in the M-1959 were not the problem, but the reach distance to close the cover led to several burns, particularly for the shorter cooks. This situation could perhaps be improved by reducing the size of the base onto which the ranges are anchored. In addition, this anchoring itself was a safety hazard as ranges sometimes pulled loose when heavy pots were moved forward on the lowered range door. The base made the door support too short to reach the floor. The height to the squarehead pans on the serving line was 42 inches, six inches too high for ideal performance.

The metal floor of the trailers presented some problems in the cleaning process. As some of the workers indicated, the wash water carried the food particles with it underneath the trailers presenting a sanitation problem. Also the water could soften the ground allowing wheels and supports to sink unevenly. In a related area, the addition of mop pails to the trailer equipment is suggested since the cooks resorted to using cooking pots as a substitute. The recently washed metal surface was extremely slippery and more extensive use of rubber matting is suggested.

It is recognized that the central platform was somewhat improvised for the exercise; however, not only was it tilted but several of the jointing materials protruded as much as 1/2 inch providing a severe tripping hazard. This area did provide a useful location for work tables and storage cabinets and was utilized for much of the before cooking preparation.

The stairs leading up to the trailer had the correct riser height of 7-3/4 inches - except for both the top and bottom step which were both nearer 4-3/4 inches in height. This discrepancy provided a serious descent hazard for several cooks and customers, who were observed to falter on the second (longer) step, and fall on the third (particularly when carrying a pot or tray which obscured their feet from their vision). The riser heights should be uniform and be somewhere in the range from 5 to 8 inches (ideally 6.5 to 7 inches). Also, the tread on one stair should extend under the nosing of the stair above. The railings for the stairs were exactly the correct height, but were too loose to provide firm support. In a related area, the railing running around the trailer was approximately seven inches too high (43 instead of 36) and too weak to support the weight of the average Marine.

Under miscellaneous considerations, handwashing consisted of using two coffee cans, one of soapy water and one of rinse water, with some paper towels. This arrangement soon becomes unsanitary and a better one is needed. In addition, placing food in insulated containers for distribution to remote areas was an inefficient operation. If containers were placed on working tables, they were too high for the cooks to comfortably reach. As a result, filling took place on the floor, and a worker who stoops or bends for any length of time is relatively inefficient and highly susceptible to fatigue. Adjustable tables which could be lowered so that containers placed on it would be 36 inches high are recommended.

Conclusions

1. The control system has numerous inherent human factors deficiencies which contribute significantly to inefficient operation. The most serious of these are the hot working environment, even in low ambient temperatures; the shelter size which requires the use of two shelters, one for cooking and one for serving and loading food containers and the lack of adequate equipment, especially the lack of griddles, steam tables, labor saving devices and inadequate pot washing operations.

2. The XM-75 system was superior to both the control and XM-76 systems from a human factors point of view and solves most of the problems uncovered with the control system.

3. The XM-76 system, although offering a number of improvements over the control system, has serious workspace design problems. In particular, the tight quarters caused by the workspace layout and removal of burner units.

CHAPTER XI

CONSUMER MESS GEAR ACCEPTANCE

At selected meals during the experiment, consumers at both the kitchen and remote area locations were asked to rate the standard metal mess kit with its utensils and metal canteen cup versus a disposable fiberboard tray with plastic utensils and a paper cup. Respondents were asked to rate both the gear they were using at that meal and the other gear using a five point scale (sample survey form in Appendix G). One exception was paper cups which were used throughout the experiment because canteen cups were not available. Results were initially analyzed separately for personnel surveyed at the kitchen site and in forward areas, as well as by which type of gear was being used at the time of the survey. Since no difference in response patterns appeared other than a tendency to rate the gear being used slightly higher than the alternative, the data is presented as a composite.

All Components

Table 21 shows the mean ratings for each attribute included in the survey and the mean overall ratings for each component in the standard and disposable systems. The overall component means show a statistically significant consumer preference for each component of the disposable service (tray, utensils and cups).

Disposable Tray/Mess Kit: The mean for each of the attributes shows the preference for the disposable service even more vividly, and, in some instances, provides clues for the reasons behind the preferences. Not only was the disposable tray preferred over the mess kit overall, but it scored higher on each of the six attributes (statistically significant on 4 of the 6). One attribute which is of particular importance in view of the current A-ration menu is the lack of space the mess kit provides. Clearly consumers felt there was more capacity in the disposable tray. Also, its five compartments keep more meal components separate than the two piece mess kit, which has a total of three compartments.

Utensils: The plastic utensils were also preferred and rated the same or higher on each of the four attributes (2 of the 4 statistically significantly). The sole reason seems to be their disposability and resultant sanitary condition since the other attributes assessed, size and cutting ease, were not rated significantly different.

Cups: The paper cup also was preferred and rated the same or higher on all five attributes tested (2 of the 5 were statistically significantly). Again the biggest difference centered around the sanitation and cleaning issues.

TABLE 21. MESS GEAR ATTITUDE RATINGS

Attribute		Mean Rating* Standard	Disposable
Tray/Mess Kit:	Sanitation	3.3	4.1[D]
	Easy to Clean	3.5	4.3[D]
	Space for Food	2.9	3.8[D]
	Easy to Carry Filled	3.2	3.8[D]
	Easy to Cut On	3.4	3.6
	Food Stays Hot	3.1	3.4
	OVERALL	3.3	3.9[D]
Utensils:	Sanitation	3.2	4.2[D]
	Easy to Clean	3.5	4.2[D]
	Size of Each	3.7	3.9
	Easy to Cut With	3.6	3.6
	OVERALL	3.6	4.0[D]
Cups:	Sanitation	3.3	4.2[D]
	Easy to Clean	3.4	4.1[D]
	Easy to Carry	3.7	3.8
	Easy to Fill	3.7	4.0
	Large Enough	3.7	3.7
	OVERALL	3.6	4.0[D]

*Five-point Likert scale: 1(Very Bad), 2(Bad), 3(Neither Bad nor Good), 4(Good), and 5(Very Good).

[D]Statistically preferred at the 2% level of significance.

Conclusions

1. All three components of the disposable service - the fiberboard tray, the plastic utensils, and the paper cup - were preferred over the components of the standard mess kit by consumers at the kitchen site as well as the remote feeding sites.

2. The most consistent reason for this preference appears to be related to sanitation and cleaning issues. However, the consumers also rated the space for food in the disposable tray as significantly greater than in the mess kit, confirming observations made during the experiment that the mess kit was not designed for the modern multiple component field rations.

APPENDIXES

Appendix A

Equipment Performance

XM-75 Kitchen Tent

The XM-75 kitchen tent represented a big improvement over the standard kitchen shelter, the G.P. medium tent. The multiple doorways coupled with the size (16'W x 40'L) of the XM-75 kitchen tent permitted the establishment of two serving lines within the kitchen shelter. This is not possible with the standard system and requires the use of an additional shelter for this purpose. The doorways, windows, and vents provided excellent ventilation. The ventilation was so good that several vents often had to be closed during the cool evening and early morning hours to retain some of the heat generated by the M-2 burners within the shelter. The fly above the tent was very effective in providing protection from the hot sun and rain.

The entire XM-75 kitchen, shelter and equipment, was erected and set-up in about one and a half hours. The cooks had erected the tent and equipment only one time before. Erecting the tent was considered by many to be easier than erecting the G.P. medium tent.

The XM-75 tent was 16'W x 40'L. Sixteen feet of the tent was utilized as a serving area while 24 feet of the tent was utilized as a food preparation area. Due to an expanded serving line, approximately 20 feet long, a portion of the serving line, 4 feet, extended past the end of the shelter. For this reason, some felt that a 48 foot shelter would be better, so the entire expanded serving line could be enclosed during inclement weather.

XM-76 Platform

A sectional aluminum platform was designed and constructed at Natick to permit the 3 MKT's to be joined into a single kitchen unit and to provide necessary additional workspace. The method of erecting and securing the platform to the trailers, however, required the alignment of 2 of the MKT's to within 1/4 inch of each other. Consequently, a great amount of time and manpower was consumed on numerous realignments and relevelings of the trailers. If the XM-76 concept is to be pursued, the platform would have to be redesigned to permit quick and easy installation on uneven ground.

Tables, Stainless Steel

The tables provided were modified commercial tables which could be completely knocked down for very efficient transport. The tables were double shelved. The shelves were provided with tapered holes. The bottom shelf was provided with larger holes than the top shelf. The legs were provided with a permanently attached sleeve to support the bottom shelf and was tapered to support the top shelf. As a result, the tables could be easily and rapidly assembled or disassembled as required. Adjustable foot plates were provided for leveling of the tables on uneven ground.

Griddle

The griddle used in the XM-75 kitchen is similar in design to those used in the Mobile Kitchen Trailer except for the stand itself. The heat source is two M-2 burner units. The griddle was made of anodized aluminum and was reversible. A one and a half inch lip around each side of the griddle made for easy placement or removal of the griddle top as required. Heat shields were provided to protect the cooks and customers. An exhaust stack, 42" high, was provided between each pair of griddles, steam tables, or combination thereof. These exhaust stacks were very effective in creating a draft and transporting most of the heat and fumes coming off the bottom of the griddles and steam tables to the vents above. The temperature of the air coming from the top of the stack was measured to be in excess of 600°F. Splatter guards were provided on three sides of the griddle to prevent the splattering of grease. A grease shoot was provided to drain excess grease from the griddle to a #10 can placed on the ground.

The griddle was very popular and often used to prepare various menu items. The cooks considered the griddle to represent a big improvement over the squarehead cover which is used in the standard Marine Corps field feeding system for griddling. Two design modifications are required to make the griddle a more suitable field item: (1) redesign to provide more efficient packing for movement, and (2) redesign to prevent liquid items, like scrambled egg mix, from running down the grease drain.

Steam Tables

The steam tables were designed to be supported by the same stand as the griddle. The steam table replaced the top shelf while a metal frame, designed to hold two M-2 burners, replaced the bottom shelf of the table. The steam table was designed to hold two squareheads. The steam tables were very effective in maintaining the hot components of the meal at the proper serving temperature throughout the serving period. A drain, with tapered plug, was provided in the bottom of each steam table which was slanted to facilitate easy draining. The steam table should be redesigned to facilitate more efficient packing for movement.

Salad Making Equipment

An electrically powered salad maker with assorted cutting blades was utilized with the experimental systems. The salad maker was ideal for cutting lettuce, onions, celery, cucumbers, and other firm vegetables. The machine could not be used for soft vegetables like tomatoes which would be crushed. The salad maker greatly reduced the amount of time required to make salads.

Numerous cutting blades and parts were provided with the salad maker. The blades were extremely sharp and considerable care was required especially while cleaning. Cleaning was often done by the cooks rather than the messmen.

A manual tomato wedger provided reduced preparation time and improved acceptability of the product.

Salad making is a labor intensive task. The salad maker and tomato wedger greatly reduced the amount of effort required to make a mixed salad. The salad maker performed satisfactorily, but redesign to reduce the number of parts and to facilitate cleaning would be desirable.

Electric Can Opener

The commercial model can opener used, had no means of securing it to the work table, and was therefore considered unacceptable. An electric can opener of a proper design, however, is considered highly desirable due to the great number of cans which must be opened, especially when preparing B-rations.

Hot Water Heater with Pump

A hot water heater from the standard eight man shower unit was utilized with the two experimental systems to provide the large quantity of hot water required by a battalion level field feeding system. The hot water heater, a pump, and a series of hoses transported the water from the 400 gallon water trailer through the heater to a 32 gallon G.I. can used as a holding tank where it was recirculated until the water reached a temperature of 180°F. The water was pumped from the G.I. can to the field sinks as required. If the water trailer was made of metal rather than fiberglass, the water could have been heated right in the trailer. During a previous experiment the temperature of the water in a metal water trailer (400 gallons) was raised 100°F in approximately one hour.

The hot water heater was considered to represent a big improvement over the currently authorized immersion heater/G.I. can method. Due to the high recovery rate of the hot water heater the time lost waiting for water to heat up was greatly reduced when compared to the standard system.

The hot water heater system is being redesigned slightly to provide an adequate supply of hot water without the need for a holding or circulation tank.

Field Sinks

The stainless steel field sinks utilized in the sanitation center were considered by all to represent a big improvement over the standard G.I. cans with immersion heaters. The sinks, approximately two feet square and sixteen inches deep were large enough to permit the largest item, the fifteen gallon pot, to be immersed for washing or rinsing.

Hot water at approximately 180°F was pumped into the sinks from the water heater, and was maintained hot by M-2 burners placed under the sinks.

The sinks were designed with a short tapered stack on the back side. The sinks were double walled which minimized energy consumption and facilitated the exhaust of hot fumes away from the workers.

As can be seen from the worksampling data, the sinks coupled with the hot water heater greatly reduced the man hours required to wash, rinse, and sanitize the pots, pans, and other kitchen utensils.

Wire Shelves

Commercially available open wire shelving was provided in the sanitation center for the drying and storing of cleaned pots, pans, insulated food containers, etc. The shelving was extensively utilized and was considered satisfactory in all respects except for the assembly and disassembly process, which was difficult and time consuming. The shelving provided is subject to bending during the assembly and disassembly processes since considerable hammering is required. Since a field kitchen may have to move often, or on short notice, the wire shelving provided for use during the experiment is considered unsatisfactory for general field use. However, due to the large number of pots and pans, etc., which must be sanitized for a battalion level field feeding system, some sort of shelving for the storage and drying of sanitized items is required. Wire shelving designed to facilitate easy and rapid assembly/disassembly, without hammering, is desirable.

Meat Slicer

Various items on the menu to include boneless roast turkey and roast beef, required slicing before serving. A commercial, electric meat slicer was provided with the experimental systems for this purpose. The electric meat slicer significantly reduced the amount of time expended slicing the meat when compared to doing it by hand. An added advantage was that the slices were more uniform than those done by hand thus simplifying portion control. Overall the meat slicer was considered as a desirable piece of field equipment.

Floor Boards, Plastic

Commercial floor boards were provided for the walkways within the XM-75 kitchen and sanitation center. The boards provided were considered to be unsatisfactory for field use. The connectors provided with the boards so continuous walkways could be made were ineffective and often broke. As a result various sections of the board often lifted off the ground resulting in a safety hazard. The boards provided were also extremely thin. Thus, if the ground was soft the boards would sink in and become useless.

If floor boards are desirable as a field item then they should be more pliable, thicker, sturdier and with more reliable connectors.

TABLE A-1. EQUIPMENT USAGE*

Equipment	System			
	Control	XM-75	XM-76	B-Ration
M-2 Burner	12	11	15	14
Range	12	10	8	10
Griddle	0	2	3	3
Steam Table	0	4	0	4
Pot Cradle	5	6	6	8
Square Head	14	15	15	10
Square Head Cover	10	14	9	9
15 Gal. Pot	7	12	14	13
10 Gal. Pot	6	8	10	10
Bake Rack	5	4	4	4

*Maximum number of kitchen items in use at any one time during the experiment; Sanitation Equipment was not included in this survey.

TABLE A-2. FUEL, WATER, AND ELECTRICITY USAGE

	Control	XM-75	XM-76
Gasoline (gal/day)	80*	80*	80*
Diesel Fuel (gal/day)	56	73**	-
Water (gal/day)	1280	933***	1244
Ave. Elec. Consumption (KWH)	-	5.8	6.5

* Average for the experimental period
** Water Heater used 6 gal/day (Measured over a one week period)
***Sanitation Center used 440 gal/day (Measured one day)

TABLE A-3. TOTAL TIME TO ERECT SYSTEM (MINUTES)

Control	XM-75	XM-76
90	112	270*

*Time to erect XM-76 was greatly increased due to close tolerance of prototype platform. Re-design of this platform would be expected to significantly reduce this time.

TABLE A-4. WEATHER

	Control	XM-75	XM-76
General Description	Cool and Rainy	Cool and Cloudy	Clear
Temperature Range*	30-70^{o}F	40-75^{o}F	50-80^{o}F

*From recordings made as close as convenient to 0600, 1200, and 1800 hours.

TABLE A-5. TRASH ESTIMATE FOR EXPERIMENTAL PERIOD

Wet Garbage	135 gal/day (average of two days)
Dry Trash (Kitchen)	65 ft^3/day (average first week estimate)
Dry Trash (Disposables)	112 ft^3/day (one day estimate)

NOTE: These estimates were made visually and by counting trash bags from G.I. cans

Appendix B

Work Sampling Definitions and Data

WORK SAMPLING TASK DEFINITIONS

Task No.	Title and Definition
01	Food Preparation - Other Than Baking Bread or Pastries

Obtains ingredients or items to be prepared
Obtains required pots, pans, utensils, etc.
Opens containers (boxes, cartons, cans)
Prepares, mixes, stirs, stirs ingredients
Prepares griddles or ranges for cooking (i.e., oils griddle)
Monitors cooking process
Transports prepared items to holding location prior to serving period
Slices menu items, except when done on the serving line during the serving period
Cooks food on griddle and serves directly from griddle

02 Food Preparation - Baking of Bread and Pastries

Similar to code 01 above except pertains to the baking of pastries and dessert items only,rather than other menu items

03 Ready Food for Movement to Remote Feeding Sites

Obtains, preheats, fills & labels insulated food containers
Assembles insulated food containers, miscellaneous food items, and accessories into piles for loading
Loads assembled items onto vehicles for transport to remote feeding sites

05 Serving

Sets up serving line
Serves food items (includes slicing if done on the serving line)
Assigned to and mans the serving line during the serving period, even if not actively serving someone
Replenishes serving line with additional food and beverage

06 Supply

Obtains Supplies
Unloads and places supplies into storage
Maintains storage areas
Issues Supplies

Task No.	Title and Definition
07	Kitchen Sanitation
	Transports dirtied pots, pans, utensils, etc. from the kitchen to the sanitation center Removes rubbish and garbage from the kitchen Cleans kitchen equipment Cleans grounds in and around kitchen area
08	Pot and Pan Sanitation
	Sets up and maintains equipment in sanitation center Washes, rinses, sanitizes pots, pans, insulated food containers, utensils, etc. Places or sticks sanitized items for drying Cleans ground in and around the sanitation center
09	Laundry Lines
	Sets up and maintains mess kit washlines - refuels, lights, maintains, cleans immersion heaters - fills, empties, and cleans G.I. cans - monitors mess kit washline to insure proper operation
10	M-2 Burners
	Refuels, lights positions, removes, cleans, repairs, and maintains M-2 burners
11	Other Productive
	Supervises Administrative functions such as maintaining records, attending to visitors, etc. Sick bay Weather dictated work, for example, digging trenches around the tent to prevent flooding during heavy rainstorms Productive time not covered elsewhere
12	Idle
	In the work area but not actively engaged in any productive work
13	Absent
	Not in the work area and not on a known break

Task No.	Title and Definitions
14	Meals Period
	Self explanatory

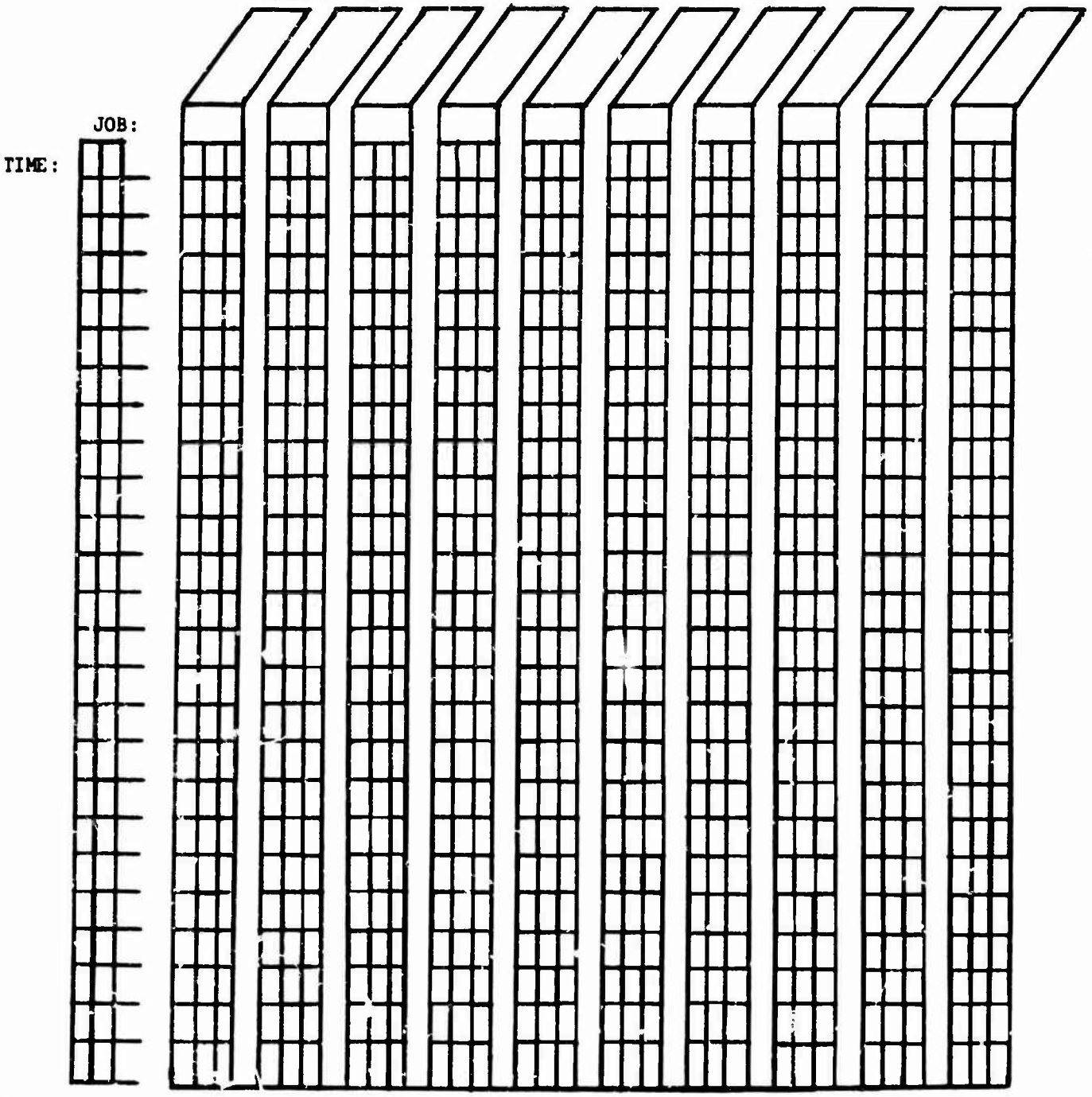
DATA COLLECTION SHEET

WORK SAMPLING

Date Time I.D.No.

Wk Mo.Day From to Observer Day of week

Col. 1 2 6 10 14 17



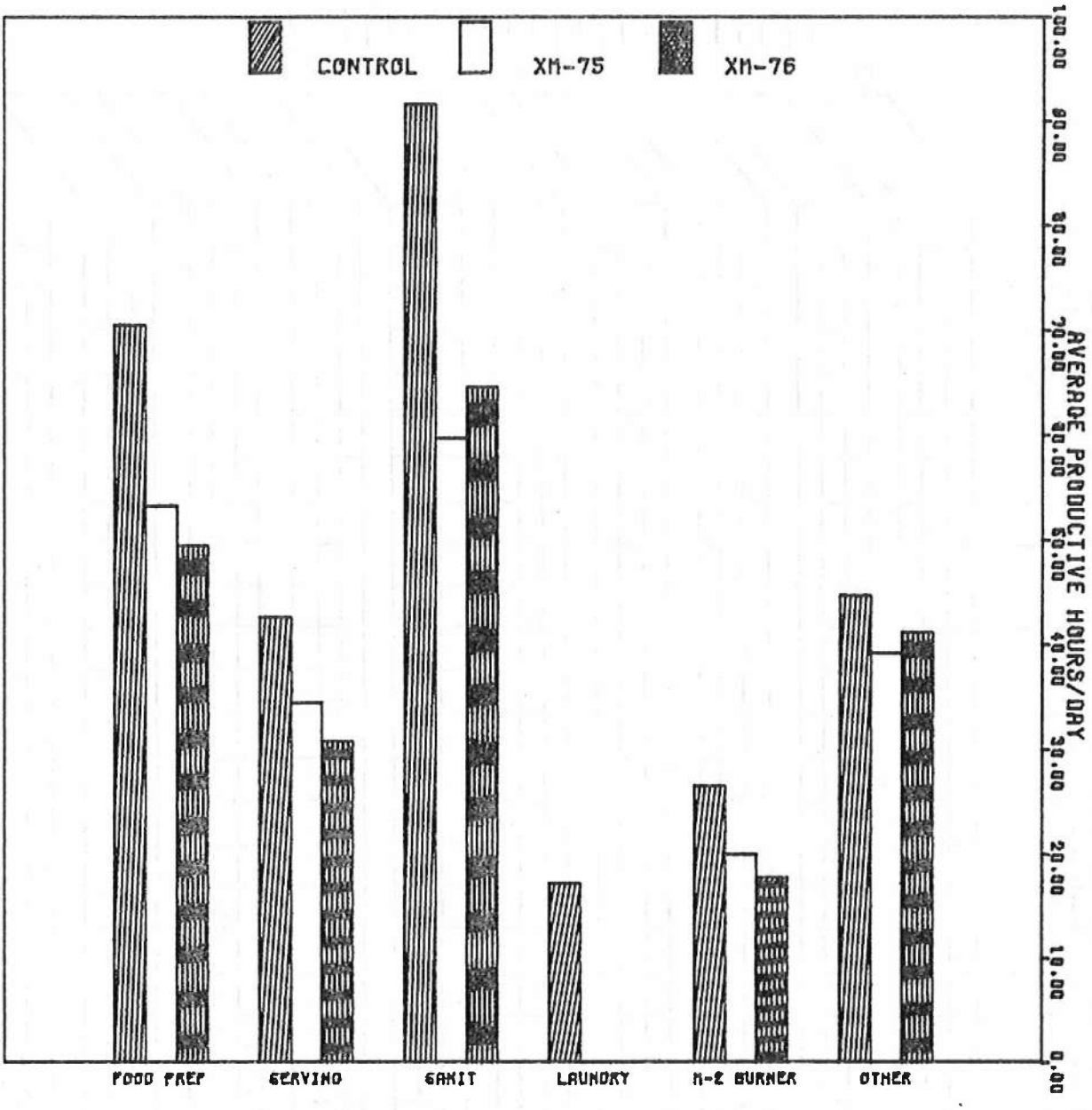


FIGURE B-1. COMPARISON OF WORKLOAD FOR ALL PERSONNEL

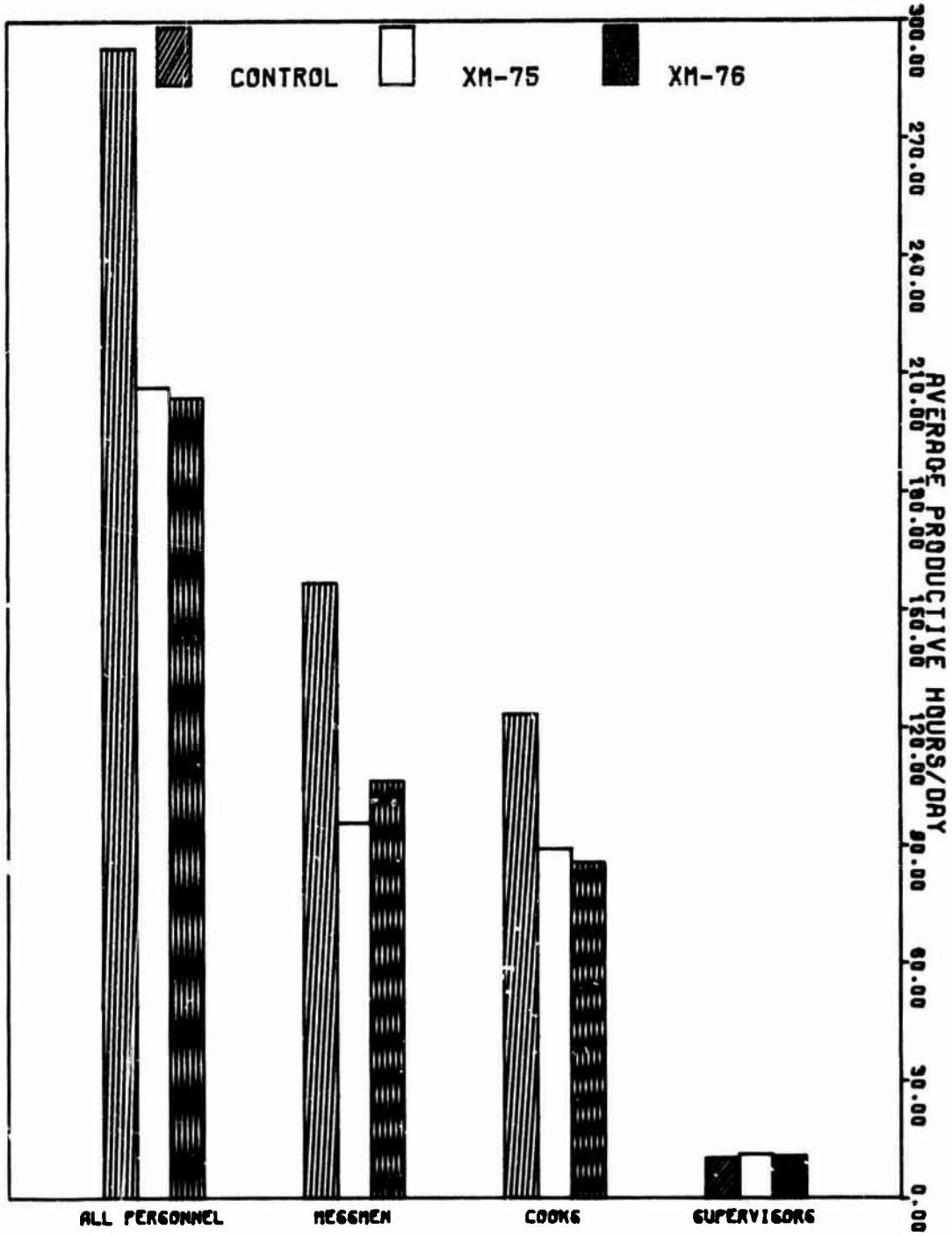


FIGURE B-2. COMPARISON OF WORKLOAD BY WORKER CATEGORY

TABLE B-1. COMBINED WORKFORCE: DAILY AVERAGE WORK HOURS

TASK	CONTROL	SYSTEM XM-75	XM-76
PRODUCTIVE			
Food Prep	57.1	40.6	38.8
Baking	13.4	12.7	10.7
Pack Food for Field	14.9	14.4	14.2
Serving	27.7	20.0	16.6
Supply	12.3	6.8	8.8
Kitchen Sanitation	32.4	27.3	34.2
Pot and Pan Sanitation	59.2	32.4	30.4
Laundry Line	17.2	0.0	0.0
M-2 Burners	26.5	20.0	17.8
Other Productive	32.4	32.4	32.4
Total Productive Time	293.1	206.6	203.9
NON-PRODUCTIVE			
Idle	99.8	63.8	88.1
Absent	26.4	21.3	29.1
Total Non-Productive Time	126.2 (30%)	85.1 (29%)	117.2 (37%)
Total Available Time	419.3	291.7	321.0
		NON-AVAILABLE TIME	
Meal Periods	34.7	21.5	35.6

TABLE B-2. SUPERVISORS AVERAGE NUMBER OF MAN-HOURS EXPENDED DAILY

TASK	AVAILABLE TIME CONTROL	XM-75	XM-76
PRODUCTIVE			
Food Prep	.1	.2	.5
Baking	0.0	0.0	.0
Pack Food for Field	0.0	.1	.1
Serving	0.0	.3	.1
Supply	.1	.3	.2
Kitchen Sanitation	.1	0.0	0.0
Pot and Pan Sanitation	0.0	.2	0.0
Laundry Line	0.0	0.0	0.0
M-2 Burners	0.0	0.0	0.0
Other Productive	10.2	10.2	10.2
Total Productive Time	10.5	11.4	11.1
NON-PRODUCTIVE			
Idle	6.0	6.7	5.2
Absent	8.0	9.2	9.3
Total Non-Productive Time	14.0(57%)	15.9(57%)	14.5(57%)
Total Available Time	24.5	27.3	25.6
		NON-AVAILABLE TIME	
Meal Periods	1.3	0.9	0.5

TABLE B-3. COOKS AVERAGE NUMBER OF MAN-HOURS EXPENDED DAILY

TASK	AVAILABLE TIME CONTROL	XM-75	XM-76
PRODUCTIVE			
Food Prep	50.3	33.8	28.8
Baking	11.0	11.5	9.6
Pack Food for Field	4.3	6.0	3.1
Serving	6.3	7.2	4.0
Supply	3.5	2.9	1.3
Kitchen Sanitation	18.5	12.1	15.3
Pot and Pan Sanitation	.5	.5	.1
Laundry Line	.9	0.0	0.0
M-2 Burners	13.1	10.1	8.5
Other Productive	15.3	15.3	15.3
Total Productive Time	123.7	99.4	86.0
NON-PRODUCTIVE			
Idle	35.8	21.9	32.5
Absent	11.2	3.9	5.2
Total Non-Productive Time	47.0(28%)	25.8(21%)	37.7(30%)
Total Available Time	170.7	125.2	123.7
		NON-AVAILABLE TIME	
Meal Periods	9.1	6.0	7.0

TABLE B-4. MESSMEN AVERAGE NUMBER OF MAN-HOURS EXPENDED DAILY

TASK	AVAILABLE TIME CONTROL	XM-75	XM-76
PRODUCTIVE			
Food Prep	6.8	6.6	9.5
Baking	2.5	1.2	1.1
Pack Food for Field	10.6	8.3	11.0
Serving	21.3	12.5	12.4
Supply	8.7	3.6	7.4
Kitchen Sanitation	13.9	15.2	18.9
Pot and Pan Sanitation	58.7	31.8	30.2
Laundry Line	16.3	0.0	0.0
M-2 Burners	13.4	9.9	9.3
Other Productive	6.9	6.9	6.9
Total Productive Time	159.1	96.0	106.7
NON-PRODUCTIVE			
Idle	58.0	35.3	50.4
Absent	7.2	8.2	14.5
Total Non-Productive Time	65.2(29%)	43.5(31%)	64.9(38%)
Total Avaliable Time	224.3	139.5	171.6
		NON-AVAILABLE TIME	
Meal Periods	24.3	14.6	28.1

TABLE B-5. COOKS PRODUCTIVE TIME BY HOUR OF THE DAY

Hour	Productive Time (Man-hours)		
	Control	XM-75	XM-76
00	2.51	2.84	1.92
01	2.95	2.60	1.92
02	5.40	3.23	2.48
03	8.55	7.15	4.71
04	8.43	7.97	6.27
05	6.71	5.90	5.51
06	4.28	3.71	5.21
07	6.62	3.87	5.30
08	5.46	4.26	3.19
09	4.61	2.86	1.32
10	3.02	2.31	1.58
11	2.57	2.50	1.43
12	3.82	2.49	1.95
13	7.43	4.45	4.68
14	8.80	6.96	5.61
15	6.90	5.21	6.42
16	7.35	5.89	5.64
17	6.16	5.27	3.85
18	5.93	3.57	3.76
19	5.55	4.80	3.18
20	2.82	3.42	3.03
21	2.78	2.60	2.78
22	2.35	2.60	2.18
23	2.54	2.83	2.12

TABLE B-6. MESSMEN PRODUCTIVE TIME BY HOUR OF THE DAY

Hour	Productive Time (Man-hours) Control	XM-75	XM-76
00	1.39	.79	.64
01	.67	.83	.53
02	.39	.87	.97
03	5.20	3.09	4.80
04	12.16	6.52	9.27
05	11.81	6.35	9.72
06	10.02	3.98	6.49
07	10.30	6.61	7.52
08	9.80	7.01	7.55
09	9.53	6.26	4.60
10	8.26	4.93	7.42
11	3.33	4.15	1.91
12	3.10	2.22	.83
13	9.42	3.72	3.40
14	8.72	5.52	4.41
15	9.82	7.10	7.43
16	9.16	6.56	7.47
17	8.26	4.72	5.38
18	10.24	5.41	6.97
19	11.00	4.68	5.56
20	3.76	2.07	1.71
21	1.03	.90	.81
22	.44	.98	.79
23	1.15	.74	.53

Appendix C

Food Operations Data and Menu

MENU - 5 DAY MODIFIED A-RATION

(Parentheses refer to Armed Forces Recipe Service Designations)

DAY 1

Breakfast

Chilled Orange Juice
Fresh Apple
Ready-to-Eat Cereal
Scrambled Eggs
Eggs to Order (F-13)
Baked Sausage (L-88)
Hashed Brown Pot. (Q-54)
Sweet Rolls (D-36)
Bread
Butter
Jam or Jelly
Coffee (C-4)
Milk

Dinner

Tomato Soup (P-6)
Pork Chops (L-85-1)
Applesauce
Mashed Potatoes (Q-57)
Peas (Q-G-1)
Lettuce & Tomato Salad (M-33)
French Dressing (M-58)
Strawberry Shortcake (G-34)
Bread
Butter
Coffee (C-4)
Milk

DAY 2

Breakfast

Chilled Orange Juice
Fresh Apple
Ready-to-Eat Cereal
Scrambled Eggs
Eggs to Order (F-13)
Sausage Links (L-88)
Creamed Ground Beef (L-30)
Biscuits (D-1)
Bread
Butter
Jam or Jelly
Coffee (C-4)
Milk

Dinner

Chicken Broth
Roast Turkey (L-143)
Gravy (O-16-6)
Bread Dressing (O-21)
Cranberry Sauce
Mashed Potatoes (Q-57)
Green Beans (Q-G-1)
Tossed Green Salad (M-47)
Vinegar and Oil Dressing (M-72)
Chilled Peaches
Chocolate Brownies (H-2)
Bread
Butter
Coffee (C-4)
Milk

DAY 3

Breakfast

Chilled Orange Juice
Fresh Apple
Ready-to-Eat Cereal
Scrambled Eggs
Eggs to Order (F-13)
Ham (L-65)
Home Fries (Q-54)
Sweet Rolls (D-36)
Bread
Butter
Jam or Jelly
Coffee (C-4)
Milk

Dinner

Vegetable Broth (P-26)
Roast Beef (L-5)
Natural Gravy (O-18)
Mashed Potatoes (Q-57)
Whole Kernel Corn (Q-G-1)
Tossed Salad (M-33)
Garlic French Dressing (M-60)
Banana Cream Pudding (Cnd)
Hermits (H-17)
Bread
Butter
Coffee (C-4)
Milk

ALL LUNCHES ARE MEAL-COMBAT-INDIV.

MENU - 5 DAY MODIFIED A-RATION (CONTINUED)

DAY 4

Breakfast

Chilled Apple Juice
Fresh Orange
Ready-to-Eat Cereal
Scrambled Eggs (F-13)
Creamed Ground Beef (L-30)
Sausage Links (L-88)
Hashed Brown Pot. (Q-54)
Cinnamon Rolls (D-42)
Bread
Butter
Jam or Jelly
Coffee (C-4)
Milk

DAY 5

Breakfast

Chilled Orange Juice
Fresh Orange
Ready-to-Eat Cereal
Scrambled Eggs (F-13)
Bacon (L-2/3)
Hashed Brown Pot. (Q-54)
Quick Coffee Cake (D-13)
Bread
Butter
Jam or Jelly
Coffee (C-4)
Milk

ALL LUNCHES ARE MEAL-COMBAT-INDIV.

Dinner

Chicken Broth
Barbequed Chicken (L-128)
O'Brien Potatoes (Q-54)
Peas (Q-G-1)
Lettuce Salad (M-32)
Radishes (2#100)
Russian Dressing (M-67)
Chilled Fruit Cocktail
Sugar Cookies (H-27)
Bread
Butter
Coffee (C-4)
Milk

Dinner

Tomato Soup
Grilled Steak (L-7)
Baked Potatoes (Q-44)
Sour Cream
Mexican Corn (Q-27)
Spring Salad (M-44)
French Dressing (M-58)
Apple Cobbler (I-G-5)
Bread
Butter
Coffee
Milk

MENU: 3-DAY B-RATION

(Parentheses Refer to Standard B-Ration Recipe Designations)

DAY 1

Breakfast

Orange Juice (F-2)
Cheese Omelet (E-2)
Bacon (G-1)
Bread
Margarine
Grape Jelly
Coffee (A-2)
Cocoa (A-1)
Milk

Dinner

Pea Soup (I-3)
Beef Patties Jardinae (G-12)
Mashed Potatoes (J-17)
Biscuits (B-2)
Bread
Margarine
Brownies (C-4)
Chilled Fruit Cocktail
Coffee (A-2)
Beverage Base
Milk

DAY 2

Breakfast

Grapefruit Juice (F-3)
Oatmeal w/Milk (D-5)
Scrambled Eggs (E-1)
Bacon (G-1)
Hashed Brown Pot. (J-15)
Bread
Margarine
Grape Jelly
Coffee (A-2)
Cocoa (A-1)
Milk

Dinner

Chicken-Noodle Soup (I-1)
Creamed Chicken (G-18)
Steamed Rice (D-4)
Buttered Peas (J-11)
Cranberry Sauce
Biscuits (B-2)
Bread
Margarine
Oatmeal Cookies (C-5)
Chilled Peaches
Coffee (A-2)
Beverage Base
Milk

DAY 3

Breakfast

Orange Juice (F-2)
Ham Omelet (E-2)
Hashed Brown Potatoes (J-15)
Bread
Margarine
Grape Jelly
Coffee (A-2)
Cocoa (A-1)
Milk

Dinner

Onion Soup (I-2)
Pork Chops (G-32)
Mashed Potatoes (J-17)
Buttered Corn (J-11)
Corn Bread (B-3)
Bread
Margarine
Chocolate Pudding (C-14)
Vanilla Sugar Cookies (C-6)
Coffee (A-2)
Cocoa (A-1)
Beverage Base
Milk

ALL LUNCHES ARE MEAL-COMBAT-INDIV.

TABLE C-1. "A"-RATION COST SUMMARY

Meal Day	Breakfast	Lunch*	Dinner	Total
1	$0.51	$1.46	$1.29	$3.27
2	0.63	1.46	0.79	2.89
3	0.70	1.46	1.04	3.21
4	0.67	1.46	0.78	2.93
5	0.52	1.46	1.91	3.91
Ave.	0.61	1.46	1.16	3.24
%	19%	45%	36%	100.0%

TABLE C-2. "B"-RATION COST SUMMARY

Meal Day	Breakfast	Lunch*	Dinner	Total
1	$0.68	$1.46	$1.18	$3.33
2	0.67	1.46	0.69	2.83
3	0.47	1.46	1.22	3.16
Ave.	0.61	1.46	1.03	3.11
%	20%	47%	33%	100%

*Average cost of the M-C-I from the last procurement.

MENU DAY	FOOD ENERGY (K CAL)	PROTEIN (GM)	FAT (GM)	CALCIUM (MG)	IRON (MG)	VTMN A (IU)	THIAMINE (B1 MG)	RIBO FLAVIN (B2 MG)	NIACIN (MG)	ASCORBIC ACID (C MG)
1	4091	157.7	184.6	1448	26.4	9685	5.61	3.48	31.9	220.8
2	4487	187.9	206.0	1405	28.8	9045	5.41	3.87	41.3	134.5
3	4231	178.1	201.1	1370	26.7	9979	5.01	3.49	33.8	144.8
4	4358	191.3	191.5	1557	27.8	9082	5.18	3.94	43.0	155.2
5	4416	168.3	208.7	1347	27.2	9186	4.84	3.47	34.5	232.0
DDA	3400	100.0	191.8	800	14.0	5000	1.70	2.00	22.0	60.0
AVE	4317	176.7	198.4	1425	27.4	9395	5.21	3.65	36.9	177.5
PCT	127%	177%	103%	178%	196%	188%	306%	183%	168%	296%

Figure C-1. Nutrition Summary: "A" Ration

1	4068	163.7	195.4	1574	23.90	8353	5.21	3.70	29.7	145.4
2	4354	157.8	182.4	1449	24.41	7767	5.36	3.47	31.9	122.1
3	4203	150.8	173.3	1719	23.13	7996	5.41	3.86	28.6	138.4
DDA	3400	100.0	187.0	800	14.00	5000	1.70	2.00	22.0	60.0
AVE	4208	157.4	183.7	1581	23.81	8039	5.33	3.68	30.1	135.3
PCT	124%	157%	98%	198%	170%	161%	314%	184%	137%	226%

Figure C-2. Nutrition Summary: "B" Ration

MENU DAY	FOOD ENERGY (K CAL)	PROTEIN (GM)	FAT (GM)	CALCI (MG)	IRON (MG)	VTMN A (IU)	THIAMINE (B1 MG)	RIBO FLAVIN (B2 MG)	NIACIN (MG)	ASCORBIC ACID (C MG)
Breakfast										
1	939	33 5	51.0	419	6.3	1650	.86	.77	4.8	54.5
2	1226	52.8	59.3	447	9.7	1784	.95	1.20	10.3	48.2
3	1159	43.5	55.6	424	7.0	1827	1.01	.81	6.5	52.1
4	1308	55.4	63.4	578	9.3	1578	1.07	1.19	10.5	55.0
5	1084	31.9	53.6	477	5.4	1949	.71	.79	4.7	94.8
AVE.	1143	43.4	56.6	469	7.6	1758	.91	.95	7.4	60.9
DDA/3	1133	33.3	50.8	266	4.7	1667	0.57	0.67	7.3	20.0
PCT	101%	130%	111%	176%	162%	105%	160%	142%	101%	305%
Lunch(M-C-I)										
1-5	1674	74.3	67.7	429	10.9	5010	2.93	1.67	15.5	57.8
AVE.	1674	74 3	67.7	429	10.9	5010	2.93	1.67	15.5	57.8
DDA/3	1133	33.3	74.4	266	4.7	1667	0.57	0.67	7.3	20.0
PCT	148%	223%	91%	161%	233%	301%	514%	249%	211%	289%
Dinner										
1	1477	49.9	65.8	600	9.3	3025	1.83	1.04	11.6	108.5
2	1586	60.9	79.0	529	8.2	2251	1.53	.99	15.5	28.5
3	1398	60.3	77.8	517	8.8	3142	1.08	1.01	11.8	34.9
4	1376	61.6	60.4	550	7.6	2494	1.22	1.08	17.0	42.4
5	1658	62.2	87.3	441	10.7	2227	1.20	1.01	14.3	79.4
AVE.	1499	59.0	74.1	527	8.9	2628	1.37	1.03	14.0	58.7
DDA/3	1133	33.3	67.1	266	4.7	1667	0.57	0.67	7.3	20.0
PCT	132%	177%	112%	198%	191%	158%	240%	154%	191%	294%

Figure C-3. Nutrition by Meal for "A"-Ration

MENU DAY	FOOD ENERGY (K CAL)	PROTEIN (GM)	FAT (GM)	CALCIUM (MG)	IRON (MG)	VTMN A (IU)	THIAMINE (B1 MG)	RIBO FLAVIN (B2 MG)	NIACIN (MG)	ASCORBIC ACID (C MG)
Breakfast										
1	1028	41.1	62.7	698	4.6	1197	.71	1.04	4.1	43.7
2	1206	37.4	65.8	547	5.5	783	1.02	.92	5.4	39.1
3	901	31.8	43.5	544	5.1	987	.82	.86	4.3	49.8
AVE.	1045	36.8	57.3	596	5.0	989	.85	.94	4.6	44.2
DDA/3	1133	33.3	46.4	266	4.7	1667	.57	.67	7.3	20.0
PCT	92%	111%	123%	223%	108%	59%	149%	140%	63%	221%
Lunch(M-C-I)										
1-3	1674	74.3	67.7	429	10.9	5010	2.93	1.67	15.5	57.8
AVE.	1674	74.3	67.7	429	10.9	5010	2.93	1.67	15.5	57.8
DDA/3	1133	33.3	74.4	266	4.7	1667	0.57	0.67	7.3	20.0
PCT	148%	223%	91%	161%	23[illegible]%	301%	514%	249%	211%	289%
Dinner										
1	1366	48.3	65.0	448	8.4	2147	1.58	.99	10.1	43.9
2	1474	46.1	48.9	474	8.0	1974	1.42	.88	11.0	25.2
3	1627	44.7	62.1	746	7.2	1999	1.66	1.34	8.8	30.8
AVE.	1489	46.4	58.7	556	7.9	2040	1.55	1.07	10.0	33.3
DDA/3	1133	33.3	66.1	266	4.7	1667	0.57	0.67	7.3	20.0
PCT	131%	139%	89%	209%	168%	122%	272%	160%	136%	166%

Figure C-4. Nutrition by Mcal for "B"-Ration

TABLE C-3. FOOD PREPARATION TIMES AND NOTES

Item	Amount for 900 Portions	Equipment	Cooks (Time)	Man-Hours	Notes
Vegetables	36-#10 cans	Can Opener, 2-15 gal pots with cradles	2(1/2 hr) to open cans 1 (1-1/2 hr) to heat 1 (1/2 hr) to mermite	3 hr	Electric opener difficult for 1 cook to use; If ovens in use, stove tops used to heat; then need 5-10 gal pots
Mashed potatoes	9-#10 cans	Can Opener, 2-15 gal pots with cradles	1 (1/4 hr) open cans 1 (1-1/2 hr) heat water 2 (1/2 hr) to mix 1 (1/2 hr) to mermite	3¼ hr	When hand mixed in 15 gal pot potatoes were usually left too wet
Baked Potatoes	120#	2-15 gal pots 8 squareheads	2 (1 hr) oiling 1 (1-3/4 hr) cook	3-3/4 hr	Issue should have been 500 pounds
Salad (Lettuce & Tomato)	3 cs Let. 3 cs Tom.	Veg. Cutter, Tom. Cutter, whatever pots or sqhds available	1 (1 hr) Trimming Let. 2 (1 hr) Slicing Let. 1 (1 hr) Wedger Tom. 1 (1/2 hr) Mixing	4½ hr	Veg. cutter handy but needs redesign; tomatoes do not need coring with wedger, use sporatic
Brownies	-	20 Field pans, 4 bake sets	2 (1-1/4 hr) mix & pan 1 (1-1/2 hr) bake 1 (1 hr) cut & wrap	5 hr	Representative of pastry
Stuffing	-	20 Field pans	2 (2 hr) break bread 1 (2 hr) mix & pan	6 hr w/o cooking	Cooked when they could be fitted on top of ovens, pots, etc
Pork Chops	288#	3 ovens using sqhd covers as grills	3 (2 hr) + 1 (2 hr)	8 hr	20-24 chops/cover; 1/4 hr/batch
Pork Chops	285#	2 grills (4 M-2's)	1 (3 hr)	3 hr	50 chops/grill; 1/3 hr/load

TABLE C-3. FOOD PREPARATION TIMES AND NOTES (cont'd)

Item	Amount for 900 Portions	Equipment	Cooks (Time)	Man-Hours	Notes
Turkey	360#	8 squareheads, 2 squareheads per oven	1 (6 hr) pan & cook 3 (2 hr) sliced manually	12 hr	Boneless, raw, netted; must change top and bottom pans hourly; 3/sqhd, 15# each
Turkey	360#	Same	1 (6 hr) pan & cook 2 (1-1/2 hr) slice	9 hr	Same, except machine sliced
Roast Beef	360#	14 squareheads, 2 squareheads per oven	1 (4 hr) pan & cook 3 (3 hr) sliced manually	13 hr	Must change top and bottom pans hourly; 6/sqhd, 4-5#/piece
Roast Beef	360#	Same	1 (4 hr) pan & cook 2 (2¼ hr) slice	8½ hr	Same, except machine sliced
Scrambled Eggs	6 cases	3 squareheads, 3 ovens	1 (1-1/2 hr) break 3 (2 hrs) cook	6 hr	Much waste on sides of sqhd - 1/3 hr/load
Scrambled Eggs	Same	1 grill	1 (1-1/2 hr) break 1 (2 hrs) cook	2 hr	1/4 hr/load
Sausage	135#	23 field pans	1 (1 hr) pan 1 (3 hr) cook	4 hr	Put on cradle, on upper rack & on tops; 84-96 pan
Sausage	Same	1 grill	1 (2 hr)	2 hr	294-300/load
Hashed browns	40#	2 squareheads or covers	1 (3-1/2 hr)	3½ hr	3/4 hr/load; 6 qts/sqhd; 3 qts/cover; 2 sqhd
Hashed browns	Same	2 grills	2 (1 hr)	2 hr	1/3 hr/load; 4 qts grill
Creamed beef	90# Beef	3 squareheads	2 (1-1/2 hr) + 1 (1 hr)	4 hr	3/4 hr/batch
Bacon	140#	2 squareheads	2 (3 hr)	6 hr	4#/load; 6 loads/hr
Bisquits	-	3 bake sets	2 (2-1/2 hr) mix, cut, grease & pan 1 (1 hr) cook	6 hr	72/pan; 1/3 hr/load; splash guard also used for baking; each holds 60

Appendix D

Consumer Acceptance Data and Forms

TABLE D-1. HEDONIC RATINGS FOR "A" RATION BREAKFASTS

MENU DAY	FOOD ITEM	REAR			FORWARD		
		CONTROL	XM-75	XM-76	CONTROL	XM-75	XM-76
1	Fresh Orange	8.16	7.00			6.84	
	R-T-E Cereal	7.69	7.44			6.50	
	Scrambled Eggs	7.09	5.76			6.35	
	Bacon	7.23	6.25			6.57	
	Hash Brown Potatoes	5.00	4.74			5.35	
	Bread	6.95	5.86			6.91	
	OVERALL	6.95	6.14			6.27	
2	Fresh Apple	7.50	6.73	7.25	8.55	8.06	7.85
	R-T-E Cereal	7.20	7.33	7.62	8.00	7.20	6.00
	Scrambled Eggs	5.76	6.04	6.50	6.86	7.12	6.65
	Sausage Links	6.00	6.33	6.75	7.50	7.42	6.81
	Biscuits	7.12	6.00	7.25	7.93	7.75	7.00
	Bread	6.68	5.09	6.32	7.96	7.75	6.13
	OVERALL	6.11	5.70	7.00	7.63	7.42	7.47
3	Fresh Apple	7.06	7.95	7.45	8.23	7.94	8.25
	R-T-E Cereal	7.65	7.00	7.96	7.00	9.00	7.60
	Scrambled Eggs	6.91	6.57	6.78	6.84	6.38	7.00
	Ham	7.32	7.23	7.39	7.84	7.21	7.83
	Home Fries	5.87	5.00	5.67	6.28	4.25	5.96
	Sweet Rolls	7.38	6.14	6.83	7.17	7.00	7.75
	Bread	7.10	6.35	6.30	7.81	5.88	7.71
	OVERALL	6.95	6.79	7.05	7.50	6.78	7.86
4	Fresh Orange	7.05	7.32	8.50*	8.43	6.81	8.38*
	R-T-E Cereal	7.55	6.00	8.37	7.25	6.00	4.43
	Scrambled Eggs	6.83	5.91	7.48	6.38	5.39	6.52
	Creamed Beef	7.14	6.36	7.78	6.79	6.27	7.00
	Hash Brown Potatoes	6.45	3.35	7.55	6.19	4.74	5.36
	Cinnamon Rolls	7.25	6.41	8.31	7.24	6.91	7.22
	Bread	7.26	6.43	7.77	7.68	6.33	7.36
	OVERALL	6.95	6.16	8.00*	7.00	5.91	7.05*

*During Week 3, Day 4 of the experiment breakfast was served in the XM-75, not in the XM-76.

TABLE D-1. HEDONIC RATINGS FOR "A" RATION BREAKFASTS (cont'd)

MENU DAY	FOOD ITEM	REAR			FORWARD		
		CONTROL	XM-75	XM-76	CONTROL	XM-75	XM-76
5	Fresh Apple	7.10	7.53	7.50	7.60	7.13	8.05
	R-T-E Cereal	7.82	7.87	6.75	6.00	6.75	7.30
	Scrambled Eggs	6.87	6.60	7.04	4.96	5.69	6.83
	Bacon	6.28	6.65	5.89	6.48	5.62	7.29
	Hash Brown Potatoes	6.45	6.16	6.09	5.84	5.17	6.74
	Quick Coffee Cake	7.42	7.36	7.71	7.17	7.23	7.77
	Bread	7.17	6.17	6.29	7.09	6.65	6.96
	OVERALL	6.29	6.71	7.19	6.25	6.24	7.35

Notes. 1. Overall ratings refer to the separate meal ratings obtained from respondents (see sample questionnaires).

2. Hedonic Scale: 9 (Extremely Good) - 5 (Neither Good nor Bad) - 1 (extremely Bad).

TABLE D-2. HEDONIC RATINGS FOR "A" RATION DINNERS
(See Table D-1 Notes)

MENU DAY	FOOD ITEM	REAR			FORWARD		
		CONTROL	XM-75	XM-76	CONTROL	XM-75	XM-76
1	Pork Chops		6.86	7.88		7.57	7.92
	Mashed Potatoes		6.45	6.48		7.28	7.42
	Peas		6.89	7.67		7.52	7.80
	Lettuce & Tom. Salad		6.75	7.78		7.91	7.75
	Strawberry Shortcake		7.15	8.33		7.86	8.48
	Bread		7.11	6.65		7.85	7.83
	OVERALL		6.88	7.55		8.28	8.32
2	Roast Turkey	7.48	6.30	7.92		6.96	7.36
	Mashed Potatoes	7.36	6.22	7.74		5.71	6.68
	Green Beans	7.59	6.17	7.38		6.68	7.88
	Tossed Salad	7.95	6.50	8.00		6.95	8.00
	Chilled Peaches	-	-	7.79		-	-
	Chocolate Brownies	8.32	6.88	-		-	7.58
	Bread	7.68	6.09	6.71		5.85	6.84
	OVERALL	7.91	5.95	7.46		6.52	7.39
3	Roast Beef	7.52	7.30	7.88	7.77	7.92	7.20
	Mashed Potatoes	6.60	6.11	7.38	7.22	7.65	6.72
	Whole Kernel Corn	6.48	6.53	7.75	7.96	8.00	7.36
	Tossed Salad	6.81	5.06	7.77	7.76	7.29	6.79
	Banana Cream Pudding	-	7.25	7.79	7.87	-	-
	Hermits	7.38	-	-	-	7.83	7.44
	Bread	7.68	6.00	6.52	8.04	7.96	7.17
	OVERALL	7.42	6.40	7.83	7.91	7.87	7.46
4	Barbequed Chicken	7.16	6.75	7.40	6.63		7.12
	O'Brien Potatoes	6.00	3.23	6.30	5.88		6.40
	Peas	6.32	6.23	6.96	6.17		7.20
	Lettuce Salad	6.58	5.86	7.65	7.44		7.87
	Chilled Fruit Cocktail	-	6.70	-	7.50		7.79
	Sugar Cookies	7.07	-	6.21	-		-
	Bread	7.05	5.30	7.00	7.16		7.52
	OVERALL	7.11	6.26	7.29	6.52		7.26
5	Grilled Steak		8.68	8.25			
	Baked Potato		8.63	7.56			
	Mexican Corn		8.46	7.52			
	Lettuce & Tom. Salad		8.44	7.57			
	Apple Cobler		8.44	8.04			
	Bread		8.48	6.96			
	OVERALL		8.65	8.17			

TABLE D-3. HEDONIC AND TEMPERATURE RATINGS FOR "B" RATION

MENU DAY	FOOD ITEM	HEDONIC REAR	HEDONIC FORWARD	TEMPERATURE REAR	TEMPERATURE FORWARD
		BREAKFAST			
1	Cheese Omelet	4.91		2.81	
	Bacon	5.97		2.83	
	Bread	6.86		2.67	
	Coffee	-		3.00	
	Cold Beverage	-		3.00	
	OVERALL	6.07			
2	Oatmeal w/Milk	3.74	5.73	-	-
	Scrambled Eggs	3.06	3.08	2.24	2.27
	Bacon	4.31	5.30	2.24	2.38
	Hash Brown Potatoes	3.45	4.83	1.96	2.20
	Coffee	-	-	2.77	2.88
	Cold Beverage	-	-	2.85	2.52
	OVERALL	3.88	3.93		
3	Ham Omelet	5.00	4.87	2.48	2.49
	Hash Brown Potatoes	4.06	4.79	2.33	2.15
	Bread	4.91	6.33	2.63	2.89
	Coffee	-	-	2.43	2.96
	Cold Beverage	-	-	2.91	2.78
	OVERALL	5.00	5.07		
		DINNER			
1	Beef Pattie	7.53	6.69	2.91	2.67
	Mashed Potatoes	7.09	7.23	2.94	2.91
	Bisquits	7.38	6.20	2.78	2.42
	Brownies	8.03	7.27	3.05	2.81
	Coffee	-	-	3.18	-
	Milk	-	-	3.13	3.26
	OVERALL	7.39	6.79		

TABLE D-3. HEDONIC AND TEMPERATURE RATINGS FOR "B" RATION (cont'd)

		DINNER			
		HEDONIC		TEMPERATURE	
MENU DAY	FOOD ITEM	REAR	FORWARD	REAR	FORWARD
2	Creamed Chicken	6.87	5.31	3.00	2.62
	Steamed Rice	7.03	5.38	2.72	2.50
	Buttered Peas	7.10	5.65	2.96	2.41
	Bisquits	6.57	6.59	2.64	2.67
	Oatmeal Cookies	7.72	5.66	2.90	2.71
	Coffee	-	-	2.89	2.54
	Milk	-	-	3.42	3.21
	OVERALL	7.21	5.25		
3	Pork Chops	7.27	5.52	2.83	2.65
	Mashed Potatoes	7.18	5.70	2.74	2.53
	Buttered Corn	7.00	6.42	2.86	2.45
	Corn Bread	7.45	6.29	2.87	2.61
	Chocolate Pudding	7.21	5.66	3.04	2.60
	Coffee	-	-	2.86	2.64
	Milk	-	-	3.10	3.24
	OVERALL	7.19	5.96		

Notes. 1. See Table D-1 for Hedonic rating notes.

2. Temperature rated on a 5-point scale: 1(Much too Cold) - 3(Neither too Cold or too Warm - Just Right) - 5(Much too Warm).

TABLE D-4. HEDONIC RATINGS FOR "C" RATION*

FOOD CLASS	HEDONIC RATING
Main Dish	4.33
Fruit	7.14
Dessert	4.50
Jelly or Jam	4.98
Peanut Butter	3.90
Cheese Spread	3.86
Crackers	3.20
Candy	4.83
OVERALL	3.85

*All data collected on 17 March 1976 from forward unit; sample size = 84. See Table D-1 for Hedonic rating notes.

TABLE D-5. TEMPERATURE RATINGS FOR "A" RATION BREAKFASTS
(See Note 2 Table D-3)

MENU DAY	FOOD ITEM	REAR			FORWARD		
		CONTROL	XM-75	XM-76	CONTROL	XM-75	XM-76
1	Fresh Orange	2.93	3.00			2.65	
	Scrambled Eggs	2.79	2.71			2.62	
	Bacon	2.74	2.86			2.74	
	Hash Brown Potatoes	2.29	1.75			2.42	
	Bread	2.68	2.42			2.67	
	Coffee	2.82	2.87			3.05	
	Cold Beverage	3.13	3.00			2.79	
2	Fresh Apple	2.78	2.67	3.06	3.00	2.92	2.96
	Scrambled Eggs	2.47	2.65	2.90	2.45	2.80	2.50
	Sausage Links	2.63	2.43	2.89	2.57	2.84	2.67
	Biscuits	2.76	2.44	3.00	2.52	2.33	3.00
	Bread	2.70	2.30	3.06	2.94	2.77	2.48
	Coffee	2.73	3.14	3.17	3.08	2.86	3.00
	Cold Beverage	2.76	2.91	2.84	2.85	3.07	2.96
3	Fresh Apple	2.87	2.69	2.83	2.80	2.95	3.00
	Scrambled Eggs	2.94	2.65	2.83	2.81	2.36	2.64
	Ham	2.95	2.52	2.83	2.77	2.77	2.82
	Home Fries	2.67	2.05	2.67	2.46	1.95	2.20
	Sweet Rolls	3.00	2.47	2.68	2.72	2.25	2.64
	Bread	2.83	2.32	2.58	2.58	2.53	3.00
	Coffee	3.18	3.26	3.00	3.15	2.36	2.87
	Cold Beverage	2.63	3.00	2.95	2.56	2.95	3.14
4	Fresh Orange	2.85	3.00	3.00*	2.87	2.81	3.06*
	Scrambled Eggs	2.76	2.50	2.93	2.31	2.64	2.73
	Creamed Beef	2.83	2.57	2.80	2.63	2.90	2.62
	Hash Brown Potatoes	2.71	2.00	2.93	2.33	2.43	2.30
	Cinnamon Rolls	2.79	2.79	2.60	2.58	2.68	2.76
	Bread	2.62	2.64	2.86	2.88	2.72	2.84
	Coffee	3.12	3.06	3.20	2.82	3.11	2.89
	Cold Beverage	2.76	2.86	3.00	2.83	3.16	3.16
5	Fresh Apple	2.89	2.94	2.50	2.86	2.76	2.74
	Scrambled Eggs	2.72	2.73	2.95	2.36	2.61	2.83
	Hash Brown Potatoes	2.59	2.67	2.79	2.68	2.30	2.91
	Quick Coffee Cake	2.70	2.62	2.95	2.48	2.33	2.68
	Bread	2.81	2.85	2.55	2.82	2.86	2.85
	Coffee	2.84	2.71	2.55	2.95	2.67	3.00
	Cold Beverage	3.05	2.94	2.94	2.86	2.67	2.95

*During Week 3, Day 4 of the experiment, breakfast was served in the XM-75.

TABLE D-6. TEMPERATURE RATINGS FOR "A" RATION DINNERS
(See Note 2 Table D-3)

MENU DAY	FOOD ITEM	REAR			FORWARD		
		CONTROL	XM-75	XM-76	CONTROL	XM-75	XM-76
1	Pork Chops		2.60	2.96		3.00	2.82
	Mashed Potatoes		3.00	2.81		2.90	2.90
	Peas		2.69	3.16		2.71	2.73
	Lettuce & Tom. Salad		3.09	3.10		3.00	3.00
	Strawberry Shortcake		3.00	2.95		2.89	2.82
	Bread		2.75	2.89		3.00	2.95
	Coffee		3.27	3.28		3.06	2.84
	Milk		2.91	3.18		3.00	3.19
2	Roast Turkey	2.81	2.55	2.86		2.53	2.84
	Mashed Potatoes	3.05	2.75	3.09		2.61	2.68
	Green Beans	3.05	2.63	2.90		2.89	2.92
	Tossed Salad	3.10	2.72	3.05		3.06	3.00
	Chilled Peaches	-	-	3.06		-	-
	Chocolate Brownies	3.00	2.84	-		-	3.00
	Bread	2.85	2.67	2.68		3.00	3.00
	Coffee	3.14	3.16	3.00		2.71	2.68
	Milk	2.90	3.05	3.10		3.20	3.14
	Fruit Cocktail	-	-	-		3.00	-
3	Roast Beef	2.69	2.68	2.85	2.91	2.87	2.70
	Mashed Potatoes	2.64	2.53	2.80	2.96	2.83	2.92
	Whole Kernel Corn	2.93	2.89	2.94	2.78	2.87	2.88
	Tossed Salad	2.85	2.94	3.00	3.00	2.90	2.94
	Banana Cream Pudding	-	2.95	3.00	3.00	-	-
	Hermits	3.00	-	-	-	3.00	2.88
	Bread	2.86	2.83	2.70	3.00	2.95	2.95
	Coffee	3.15	3.00	3.14	3.00	3.05	2.87
	Milk	3.06	3.06	3.00	3.00	3.05	3.32
4	Barbequed Chicken	2.75	2.85	2.95	2.80		2.64
	O'Brien Potatoes	2.53	2.47	2.81	2.52		2.72
	Peas	2.63	2.89	2.86	2.53		2.64
	Lettuce Salad	3.00	3.00	3.00	3.00		2.77
	Chilled Fruit Cocktail	-	3.06	-	3.00		2.86
	Sugar Cookies	3.00	-	2.95	-		-
	Bread	2.87	3.00	2.86	2.88		2.71
	Coffee	2.79	2.94	3.06	2.57		2.96
	Milk	3.15	3.21	3.00	3.00		3.04

TABLE D-6. TEMPERATURE RATINGS FOR "A" RATION DINNERS (cont'd)

MENU DAY	FOOD ITEM	REAR			FORWARD		
		CONTROL	XM-75	XM-76	CONTROL	XM-75	XM-76
5	Grilled Steak		3.10	3.00			
	Baked Potato		3.05	2.88			
	Mexican Corn		3.00	2.92			
	Lettuce & Tom. Salad		3.00	3.05			
	Apple Cobbler		3.05	2.96			
	Bread		3.10	2.90			
	Coffee		3.11	3.14			
	Milk		3.11	3.00			

TABLE D-7. QUANTITY INTERVIEW DATA

MEAL	WEEK	QUESTION: Did you get enough food at your meals yesterday? FORWARD YES	FORWARD NO	REAR YES	REAR NO	QUESTION: Did you eat more in the field? FORWARD YES	FORWARD NO	REAR YES	REAR NO
Breakfast	1	49*	9	38	16	15	37	13	29
		84%	16%	70%	30%	29%	71%	31%	69%
Breakfast	2	32	17	27	25	6	38	13	35
		65%	35%	52%	48%	14%	86%	27%	73%
Breakfast	3	62	8	45	7	35	30	37	29
		89%	11%	87%	13%	54%	46%	56%	44%
Breakfast	4	45	8	41	4	11	38	9	26
		85%	15%	91%	9%	22%	78%	26%	74%
Dinner	1	9	9	10	6	6	9	2	12
		50%	50%	63%	37%	40%	60%	14%	86%
Dinner	2	18	18	17	19	13	23	19	17
		50%	50%	47%	53%	36%	64%	53%	47%
Dinner	3	47	7	47	7	16	34	41	11
		87%	13%	87%	13%	32%	68%	79%	21%
Dinner	4	37	17	27	0	19	35	8	14
		69%	31%	100%	0%	35%	65%	36%	64%

*Number of people responding.

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FOOD RATING SURVEY

Date: _____ Breakfast

1. Please rate how good or bad the food items you were served at this meal were by circling the number which describes your opinion. Circle one number in each row. Note that the last row asks for an overall rating of the meal.

	Extremely Good	Very Good	Moderately Good	Slightly Good	Neither Good nor Bad	Slightly Bad	Moderately Bad	Very Bad	Extremely Bad
Meat:	9	8	7	6	5	4	3	2	1
Eggs:	9	8	7	6	5	4	3	2	1
Potato:	9	8	7	6	5	4	3	2	1
Fruit:	9	8	7	6	5	4	3	2	1
Bread:	9	8	7	6	5	4	3	2	1
Sweet rolls or cakes:	9	8	7	6	5	4	3	2	1
Cereal:	9	8	7	6	5	4	3	2	1
Overall:	9	8	7	6	5	4	3	2	1

FOOD RATING SURVEY (Cont'd)

2. Please rate the serving temperature of the foods listed above. Circle one number in each row.

	Much too cold	Too cold	Neither too cold nor too warm-just right	Too warm	Much too warm
Meat:	1	2	3	4	5
Eggs:	1	2	3	4	5
Potato:	1	2	3	4	5
Fruit:	1	2	3	4	5
Bread:	1	2	3	4	5
Sweet rolls or cake:	1	2	3	4	5
Hot Beverage:	1	2	3	4	5
Cold Beverage:	1	2	3	4	5

3. If you have been in the field before this exercise, how did this food compare with other food you have been served in the field?

Don't know. This is my first time.	This food was:				
	Much Better	Better	About the Same	Worse	Much Worse
_____	_____	_____	_____	_____	_____

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FOOD RATING SURVEY

Date: _____ Meal (Circle One): Brfst. Lunch Dinner

1. Please rate how good or bad the food items you were served at this meal were by circling the number which describes your opinion. Circle one number in each row. Note that the last row asks for an overall rating of the meal.

	Extremely Good	Very Good	Moderately Good	Slightly Good	Neither Good nor Bad	Slightly Bad	Moderately Bad	Very Bad	Extremely Bad
Main Dish:	9	8	7	6	5	4	3	2	1
Potato or Rice:	9	8	7	6	5	4	3	2	1
Vegetable:	9	8	7	6	5	4	3	2	1
Salad:	9	8	7	6	5	4	3	2	1
Dessert:	9	8	7	6	5	4	3	2	1
Bread:	9	8	7	6	5	4	3	2	1
Overall:	9	8	7	6	5	4	3	2	1

FOOD RATING SURVEY (Cont'd)

2. Please rate the serving temperature of the foods listed above. Circle one number in each row.

	Much too cold	Too cold	Neither too cold nor too warm-Just right	Too warm	Much too warm
Main Dish:	1	2	3	4	5
Potato or Rice:	1	2	3	4	5
Vegetable:	1	2	3	4	5
Salad:	1	2	3	4	5
Fruit:	1	2	3	4	5
Dessert:	1	2	3	4	5
Bread:	1	2	3	4	5
Hot Beverage:	1	2	3	4	5
Cold Beverage:	1	2	3	4	5

3. If you have been in the field before this exercise, how did this food compare with other food you have been served in the field?

Don't know. This is my first time.	This food was:				
	Much Better	Better	About the Same	Worse	Worse
_____	_____	_____	_____	_____	_____

Natick R & D Command 1976

FOOD RATING SURVEY

Date: _____ C-Ration

1. Please rate how good or bad the food items you were served at this meal were by circling the number which describes your opinion. Circle one number in each row. Note that the last row asks for an overall rating of the C-Ration you ate.

	Extremely Good	Very Good	Moderately Good	Slightly Good	Neither Good nor Bad	Slightly Bad	Moderately Bad	Very Bad	Extremely Bad
Main Dish:	9	8	7	6	5	4	3	2	1
Fruit:	9	8	7	6	5	4	3	2	1
Dessert:	9	8	7	6	5	4	3	2	1
Jelly or Jam:	9	8	7	6	5	4	3	2	1
Peanut Butter.	9	8	7	6	5	4	3	2	1
Cheese spread:	9	8	7	6	5	4	3	2	1
Crackers:	9	8	7	6	5	4	3	2	1
Candy:	9	8	7	6	5	4	3	2	1
Overall:	9	8	7	6	5	4	3	2	1

FOOD RATING SURVEY (Cont'd)

2. Please rate the serving temperature of the foods listed above. Circle one number in each row.

	Much too cold	Too Cold	Neither too cold nor too warm-Just right	Too warm	Much too warm
Main Dish:	1	2	3	4	5
Fruit:	1	2	3	4	5
Dessert:	1	2	3	4	5
Hot Beverage:	1	2	3	4	5
Cold Beverage:	1	2	3	4	5

3. If you have been in the field before this exercise, how did this food compare with other food you have been served in the field?

Don't know. This is my first time.	This food was:				
	Much Better	Better	About the Same	Worse	Much Worse
_____	_____	_____	_____	_____	_____

Appendix E

Microbiological Procedures and Data

EXPERIMENTAL PROCEDURE

Microbiological Analysis

The microbiological quality of the water in the unit water trailer and in the water sterilizing bag was evaluated with Millipore total count (TCWT) and coliform (CWT) water testers. Incubation for and coliform counts was conducted in the Millipore portable sampler incubator at 37°C. The TCWT was incubated either at 37°C in Millipore incubator for 18-24 hours or at ambient temperature (20-25°C) for 48-72 hours. Isolates from a number of colonies presumptively positive for coliform by isolation from the CWT were identified at the NARADCOM facility. Identification consisted of the gram stain, mobility and keying by use of the API 20 biochemical test strips[a].

Sanitation

Rodac Plate Count: Rodac plate analysis was conducted with plates prepared by the Baltimore Biological Laboratories and the technique employed has been previously described[b]. After use the plates were incubated at ambient temperature (20°C) for 48-72 hours.

Swab Count: Swab counts were obtained by wetting a cotton swab with a buffered rinse solution[c] and swabbing a surface area 25 times each in two directions at right angles to each other. For flat surfaces a 4 in^2 (25.8 cm^2) area was swabbed. For other surfaces either the entire food contact unit (spoons, forks, etc.) or an estimated equivalent to 4 in^2 (25.8 cm^2) was swabbed. The swab was then placed into 20 ml of 0.1% peptone diluent, pH 7.0, shaken 50 times and 18 ml analyzed with a Millipore TCWT or CWT. Incubation was 48-72 hours at ambient temperature (20°C) and 24 hours at 37°C for the CWT.

Mess Kit Gear: Mess kit gear was laundered by the consumer immediately after use and placed in metal GI cans. They were then (1) used again after a dip in heated water or (2) rewashed by KP personnel, replaced into the cans and dipped in heated water by the consumer just prior to use. The metal storage cans were exposed to the weather and subjected to rain during the initial three days of the experiment. Evaluation was conducted randomly in two ways: (1) as offered to the consumer, but prior to the hot water dip or (2) randomly selected gear were examined prior to and subsequent to a dip performed by monitoring personnel. Microbiological analysis of the meat pan was conducted by RODAC plates, cup by swab count of the inner surface of the cup above the rivets or weld which secures the swival hinge to which the handle was attached, and knives-forks-spoons by a swab count of the food contact surfaces of the utensil.

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[a]Analytab Products Inc , Plainview, NY.
[b]Silverman et al, NARADCOM Tech. Repts. 75-73-FSL; 75-110-FSL.
[c]APHA, Standard Methods for the Examination of Dairy Products, 1972.

Chemical Measurements

A measurement of the chlorine content and pH was made of the potable water supply in the two trailer units. Chlorine was determined daily by the use of a field kit[a] whose results were occasionally verified by a more reliable test[b]. The pH was also measured daily with indicator paper.

Temperature

Temperatures of the water in the pot and pan washing operation and the water in the mess kit laundry line were taken mainly with a Model 392 Wahl digital thermometer[c] employing a platinum sensor. To supplement the digital thermometer a calibrated Weston dial thermometer (Model 2292) was also employed.

---

[a] Water-Chex, range 0-3.5 ppm Aseptic-Thermo Indicator Co., North Hollywood, CA.

[b] Free and Total Chlorine Test Kit, 0-3 mg/l, Model CN-66, Hach Chemical Co, Ames, IA.

[c] W. Wahl Corporation, Los Angeles, CA.

TABLE E-1. EVALUATION OF POT AND PAN SANITIZING OPERATION

Date (March)	Time	Temperature (°F) GI Can or Sink Number 1	2	3	Final Rinse APC (Organisms/ML)	Coliform (Organisms/ML)
1	1505	190		120	8	0
	1740	130	160	158		
2	1645	115	121	125		
	1645	102	117	112		
3	0440			67	TNTC	0
	0440			149	4	0
4	1430	115/170	108	105	4	0
	1510	140/150	150	108		
	1535	122/128	120	95	89	0
	1725	108/115	105	95	42	
5	0710	100/120		112/113	6	1
	0745			103	178	9
	0745			107	TNTC	TNTC
	0825	96/120		110/113		
	0915			104/106	168	0
	0945				TNTC	5
8	0650	127/115	117	129	5	0
	0650	127/115	117	129	2	0
	1500	130/130	154	134	284	16
9	0615	177/128	158	150	54	0
	1000	140/141	146	132	115	1
	1020	132/134	141	124	119	0
10	1015	174/178	181	142	3	0
	1830	114/165	152	151	9	0
11	1110	108/110	119	133	53	3
	1215	98/102	106	116	98	0
16	0440	131	180	191		
	0545	116	180	177		
	0630	136	160	182		
	0700	137	197	191		
	1525	173	160	177		
	1600	142	155	178		
	1630	135	150	188		
	1725	119	150	183		
	1815	180	145	188		
17	0430	156	166	172		
	0540	130	150	172		
	0615	122	148	180		
	1612	130	140	135		
	1650	-	145	150		
	1735	130	172	176		
18	1400	99	167	162		
	1430	172	177	180		
	1600	129	170	140		
	1630	110	120	148		
	1715	164	124	152		
	1745	140	125	150		
19	0505	168	180	162		
	0530	138	158	170		
	0600	120	150	160		

TABLE E-2. RESULTS OF MONITORING THE WATER IN THE WATER TRAILERS

		Water Trailer Number	
		373 272	376 565
Number of tests taken		15	14
pH range		6.5 - 7	6 - 7
ppm chlorine - range		0 - 1.5	0 - 1.5
	0	1	0
	$0<x\leq0.5$	7	3
	$0.5<x\leq1.0$	6	10
	$1.0<x\leq1.5$	1	1
TCWT[a]	0	7	12
	$0<x\leq10$	6	2
	$10<x\leq100$	2	0
CWT[b]	0	15	14

[a]Total count water tester organisms per gram.

[b]Coliform water tester organisms per gram.

TABLE E-3. EVALUATION OF FOOD CONTACT SURFACES BY RODAC PLATES

	Control		XM-75		XM-76	
	No. tested	Satis. (%)	No. tested	Satis. (%)	No. tested	Satis. (%)
Food Container, Insul. - gasket	2	0	13	85	1	100
- lid	36	33	21	57	2	100
- inserts	-	-	5	80	1	100
- side	1	100	2	50	2	100
- bottom	1	0	2	100	2	50
Cutting Boards - yellow	5	20	4	25	2	50
Pan, Baking & Roasting (sq hd)	8	25	14	86	9	89
Pan, Cover (sq hd)	5	60	2	100	4	75
Pot, Cooking, (large)	11	55	17	71	9	89
Cook pot cover	4	75	2	100	1	100
Beverage Dispenser, Plastic	1	100	2	100	1	0
Dipper, large	1	0	3	33	9	0
small	1	0	5	40	1	0
Knife, cook's	1	100	1	0	-	-
Pan, rectangular	10	30	14	86	12	100
Table, preparation	8	0	3	0	8	25
Table, Serving Line	-	-	36	8	18	28
Turner, Food, Wooden handle	-	-	2	50	3	67
stainless steel	4	100	3	33	3	67
Vegetable Cutter - base	-	-	2	50	-	-
- blade	-	-	5	20	-	-
- bowl	-	-	2	50	-	-
- front guard	-	-	1	100	-	-
- weight	-	-	1	100	-	-
- lid guard	-	-	1	100	-	-
- pressure plate	-	-	2	100	-	-
- plunger	-	-	2	50	-	-
Meat Slicer - blade	-	-	1	100	4	75
- slice catch area	-	-	2	0	3	33
- carriage	-	-	-	-	2	100
- panel before blade	-	-	-	-	1	0
Bowl, Mixing, lg.	-	-	2	100	1	0
Rolling Pin, wooden, lg.	-	-	3	100	-	-

TABLE E-4. EVALUATION OF FOOD CONTACT SURFACES BY SWABS

	Control		XM-75 (Organisms/Gram)		XM-76	
	Range	Ave.	Range	Ave.	Range	Ave.
Mess Kit - spoon	0-TNTC[a]	823[b]				
- knife	0-4200	470				
- fork	0-TNTC	311[b]				
Dipper	0-2140	890	100-1580	760	60-1680	590
Fork, food preparation	0-820	244	60-200	150	40-460	180
Ladle - 8 oz.	0-3100	1410	400-2720	2008	60-480	308
- 4 oz.					980-TNTC	-
- 4 oz. perforated					60-1720	707
- 2 oz.			260-5800	2462	20-780	292
- 2 oz. perforated					620	-
Skimmer	0-4700	3465	740-6440	2796	520-580	550
Tong - serving	20-1200	567	60-300	133	20-1200	286
- serving, plastic coated					100-140	120
Spoon - basting	40-3240	1085	160-1860	717	40-340	144
- basting, plastic coated					40-500	216
- slotted					460	590
Dipper	100-2140	1187	100-1580	760	60-1680	590
Turner, food	320-5540	2930	80-960	520	40-340	143
Rolling pin, wooden	0	-	40-3840	1460		
Nozzle, brown liquid dispenser			40-60	50		
Slicer, meat - blade			580-3380	1980		-
- carriage			420	-		
- curved plate			440	-		
- panel in front of blade			260,2260	1260		
Slicer, vegetable - blade			320	-		
- plunger			300	-		
Whip, large					220	-
Can opener	340-440	390				
Gasket, food container, insulated					20	-

[a]Too numerous to count

[b]Omitting the TNTC values

TABLE E-5. EVALUATION OF MESS KIT MEAT PANS BY RODAC PLATES BEFORE AND AFTER A HOT WATER DIP

	Number Tested	Temperature Water (°F)	Rodac Plates (Organism/Plate) < 50	< 100	> 100	Percentage Satisfactory[c]
Prior To Dip	140	-	74	89	51	53
Randomly Selected[a]						
- Before Dip	25	-	10	12	13	40
- After Dip	35	180/208	29	32	3	83
Matched Pairs[b]						
- Before Dip	15	-	8	10	5	53
- After Dip	15	180/192	14	14	1	93

a
Different pans were randomly evaluated prior to and after dipping.

b
The same pans were evaluated prior to and after dipping.

c
Each Rodac plate contained less than 50 organisms/plate.

TABLE E-6. EVALUATION OF MESS KIT UTENSILS BY SWABS

Item	Date (March)	No Tested	Swab Count (Organisms/Swab) 0-100	101-200	201-500	501-1000	1001-1500	over 1500
Knife	2	4	4	0	0	0	0	0
	3	7	1	2	2	2	0	0
	4	4	1	0	3	0	0	0
	5	6	1	1	1	1	0	1
Fork	1	2	0	0	0	0	0	2
	2	5	3	1	0	1	0	0
	3	7	4	3	0	0	0	0
	4	4	1	2	0	0	0	1
	5	5	1	2	0	0	0	2
Spoon	2	4	1	2	0	1	0	0
	3	7	0	0	3	1	0	3
	4	4	1	1	0	2	0	0
	5	4	1	1	1	1	0	0
TOTAL		63	19	15	10	9	0	9

Appendix F

Food Service Worker Interview and Survey Forms

FOOD SERVICE WORKER INTERVIEW

1. Number: Date:

2. What specific things did you like about the: GP Medium Tent?
   XM-1975 Test Kitchen?
   Mobile Kitchen Trailer?

3. What things did you dislike?

4. What things did you like about the serving line?

5. What things did you dislike?

6. Were there any pieces of equipment you used this week which you would single out as making your job easier or the food better? If so, how did they make it easier or better?

7. Did you have any problems with any piece of equipment and/or would you recommend any changes in any piece of equipment?

FOOD SERVICE WORKER INTERVIEW (Cont'd)

8. (For XM-1975 kitchen or MKT) What did you like about the griddle?

9. What did you dislike about the griddle?

10. (For XM-1975 kitchen) What did you like about the steam table?

11. What did you dislike about the steam table?

12. (For MKT) What did you like about the platform connecting the three trailers?

13. What did you dislike about the platform?

FOOD SERVICE WORKER ATTITUDE SURVEY

During this test, three different kinds of field kitchens are being used. Check the one you are using today.

_____ GP Medium Tent Kitchen

_____ Mobile Field Kitchen Trailer

_____ 1975 Tent Kitchen

We will be asking you several questions about all three kinds of kitchens during this test. Today we want you to help us by providing your opinion of the kitchen you are using now. If you answer each question carefully and honestly, the information you provide will be used to choose the best type of kitchen for future field use. The answers we get from all of you will be grouped for our reports so no one will be able to tell what your answers were.

1. Rank:_____ Date:_____

2. What is your duty MOS?_____

3. What is your primary duty in the kitchen for this test? (Please check one)

_____ Chief Cook

_____ First Cook

_____ Second Cook

_____ Cook

_____ Other (Please specify)_____

4. Approximately how long have you spent working in food service in the field before this exercise? (Please give an answer for both categories below on exercises or school operations, and in combat zones).

On exercises: ____Years ____Months ____Days

In combat zones ____Years ____Months ____Days

FOOD SERVICE WORKER ATTITUDE SURVEY (Cont'd)

5. Please check the item which best describes how much you like military service.

Dislike very much	Dislike moder-ately	Dislike a Little	Neither Like nor Dislike	Like a Little	Like Moder-ately	Like very much
_____	_____	_____	_____	_____	_____	_____

6. Would you like to transfer to duties other than food service? ___Yes ___ No

7. Overall, how would you rate your food service job in <u>this</u> field kitchen compared with your food service job when you are in garrison or mainside? (Please check one).

_____Much better than in garrison or mainside

_____Somewhat better than in garrison or mainside

_____About the same as in garrison or mainside

_____Much worse than in garrison or mainside

_____Not applicable, I don't work in food service in garrison or mainside

8. For each of the following categories, we would like to know how you feel about this field kitchen feeding situation. Notice that the last category asks for an <u>overall</u> rating of the kitchen. Please check one answer for each of the categories listed.

Category	Very Good	Good	Slight-ly Good	Neither Good nor Bad	Slight-ly Bad	Bad	Very Bad
a. Amount of storage space	_____	_____	_____	_____	_____	_____	_____
b. How easy to get at supplies stored in kitchen	_____	_____	_____	_____	_____	_____	_____

FOOD SERVICE WORKER ATTITUDE SURVEY (Cont'd)

Category	Very Good	Good	Slight-ly Good	Neither Good nor Bad	Slight-ly Bad	Bad	Very Bad
c. Size of kitchen	____	____	____	____	____	____	____
d. Smoke and steam	____	____	____	____	____	____	____
e. Noise	____	____	____	____	____	____	____
f. Lighting	____	____	____	____	____	____	____
g. Bumping into other cooks while working	____	____	____	____	____	____	____
h. Tempera-ture	____	____	____	____	____	____	____
i. Safety	____	____	____	____	____	____	____
j. How easy to serve customers in line	____	____	____	____	____	____	____
k. Place to fill con-tainers to send food to forward areas	____	____	____	____	____	____	____
l. Sanitation	____	____	____	____	____	____	____
m. How easy to prepare meal	____	____	____	____	____	____	____
n. How long customer waits in line	____	____	____	____	____	____	____

FOOD SERVICE WORKER ATTITUDE SURVEY (Cont'd)

Category	Very Good	Good	Slight-ly Good	Neither Good nor Bad	Slight-ly Bad	Bad	Very Bad
o. How easy to clean up	____	____	____	____	____	____	____
p. How easy would it be to move the kitchen	____	____	____	____	____	____	____
q. Insect control	____	____	____	____	____	____	____
r. How easy to pre-pare the food on this week's menu	____	____	____	____	____	____	____
s. How easy to get rid of waste water	____	____	____	____	____	____	____
t. High pressure sprayer	____	____	____	____	____	____	____
u. Overall	____	____	____	____	____	____	____

9. Did you have too many, too few or just the right number of the following types of workers for this kitchen:

Category	Much too Many	Too Many	A bit too Many	Just about Right	A bit too Few	Too Few	Much too Few
a. Supervi-sors	____	____	____	____	____	____	____

FOOD SERVICE WORKER ATTITUDE SURVEY (Cont'd)

Category	Much too Many	Too Many	A bit too Many	Just About Right	A bit too Few	Too Few	Much too Few
b. First Cooks	_____	_____	_____	_____	_____	_____	_____
c. Cooks and Apprentices	_____	_____	_____	_____	_____	_____	_____
d. Messmen	_____	_____	_____	_____	_____	_____	_____

10. In your opinion, how much workspace is there in this kitchen?

Much too Much	Too Much	A bit too Much	Just About Right	A bit too Little	Too Little	Much too Little
_____	_____	_____	_____	_____	_____	_____

FOOD SERVICE WORKER - FINAL INTERVIEW

1. Number: Date:

2. Which of the three kitchens did you like the best?

3. What is the main reason you liked it best? Any other reasons?

4. You said you liked _____ the best, could it use any changes to make it better? If so, what?

   a. Could it use any new piece of equipment added? What?

   b. Could any piece of equipment be substituted?

5. How would you compare having the same messmen for the entire three weeks to the system of changing messmen every day or so? (show card) _____

   a. What is good about "permanent" messmen?

   b. What is bad about "permanent" messmen?

FOOD CONTAINERIZING - INTERVIEW

Number: Date:

Kitchen in Use G.P. Med XM-75 MKT

1. What things are bad about the containerizing operation in this kitchen? How would you improve them?

2. What is good about the containerizing operation in this kitchen?

   (Probe for filling, storage, and assembly space problems.)

3. How would you rate the operation on this seven point scale from very easy to very hard (show card)._____

4. (Only on 3rd week) Was the setup for containerizing with one of the three kitchens any better or worse than the others? Why?

POT WASHING SURVEY - INTERVIEW

1. For each of the following categories, please tell us how you feel about the pot washing facility. Please check one answer for each of the categories listed.

Category	Very Good	Good	Slight-ly Good	Neither Good Nor Bad	Slight-ly Bad	Bad	Very Bad
a. Height of the sinks	____	____	____	____	____	____	____
b. Size of sink (is it big enough to wash large pots?)	____	____	____	____	____	____	____
c. Ease of filling sink	____	____	____	____	____	____	____
d. Ease of emptying sink	____	____	____	____	____	____	____
e. Bumping into other workers	____	____	____	____	____	____	____
f. Temperature in tent	____	____	____	____	____	____	____
g. Safety in or around tent	____	____	____	____	____	____	____
h. Ease of opening and closing tent vents	____	____	____	____	____	____	____
i. Size and number of doors	____	____	____	____	____	____	____
j. Floor slats	____	____	____	____	____	____	____
k. Ramps	____	____	____	____	____	____	____

POT WASHING SURVEY - INTERVIEW (Cont'd)

Category	Very Good	Good	Slight-ly Good	Neither Good Nor Bad	Slight-ly Bad	Bad	Very Bad
l. Ease of cleaning the tent walls	____	____	____	____	____	____	____
m. Ease of draining pots & utensils after washing	____	____	____	____	____	____	____
n. Place to dry and store washed pots	____	____	____	____	____	____	____
o. Water Temperature	____	____	____	____	____	____	____
p. Utensil rack	____	____	____	____	____	____	____
q. Wire Basket	____	____	____	____	____	____	____
r. Ease of operating the water pump	____	____	____	____	____	____	____
s. Pump & sump for waste water	____	____	____	____	____	____	____
t. High pressure sprayer	____	____	____	____	____	____	____
u. Overall	____	____	____	____	____	____	____

POT WASHING SURVEY-INTERVIEW (Cont'd)

2. In your opinion, how much workspace is there in this pot washing facility?

_____	_____	_____	_____	_____	_____	_____
Much too Much	Too Much	A Bit too Much	Just About Right	A Bit too Little	Too Little	Much too Little

3. On this seven point scale please tell us how easy or hard it was for you to keep up with the pots the kitchen sent you (show card)._____

_____

4. What was the hardest item to wash?

5. Is there any comment you'd like to make about the pot washing facility?

6. (Any responses on bad side) Why do you say _____is bad? How can it be improved?

7. What do you think could be added to make pot washing easier?

8. (For new pot shack only). Which of the two pot washing facilities did you prefer? Why?

9. Did you use the wire baskets for small items? _____ What for?

MESSMAN INTERVIEW

1. What was bad about being a messman in this exercise?

2. What was good about it?

3. Have you ever been a messman on field exercises before?
Yes_____ No_____

4. How many times or days?

5. Was there any one of the three kitchen setups which made your job easier or harder? If so, why?

6. On this seven point scale, please tell us how you felt about being a messman during this exercise. (show card) _____

Appendix G

Mess Gear Survey Form

MESS GEAR SURVEY

Date: _____ (Circle): Breakfast Lunch Dinner

Please rate the mess kits, eating utensils, and drinking cups using the following scale:

1	2	3	4	5
very bad	bad	neither good nor bad	good	very good

If an item is good for a particular category (for example, sanitation) then place the number 4 in the block provided. If it is very bad, use the number 1 and so on. Be sure to rate each piece of mess gear for each category.

		Standard Mess Kit	Disposable Tray
1.	FLATWARE		
	a. Sanitation		
	b. Easy to Clean		
	c. Amount of Space for Food		
	d. Easy to Carry Filled		
	e. Easy to Cut on It		
	f. Food Stays Hot		
	g. Overall Acceptance		

		Mess Kit Knife, Fork & Spoon	Plastic Knife, Fork & Spoon
2.	EATING UTENSILS		
	a. Sanitation		
	b. Easy to Clean		
	c. Size of Knife, Fork & Spoon		
	d. Easy to Cut With		
	e. Overall Acceptance		

		Metal Canteen Cup	Paper Cup
3.	DRINKING CUPS		
	a. Sanitation		
	b. Easy to Carry		
	c. Easy to Fill		
	d. Large Enough		
	e. Easy to Clean		
	f. Overall Acceptance		